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THE PHILIPPINE AGRICULTURIST

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LEAF SPOT AND STEM ROT OF ABACÁ [1]

VICTORIA MENDIOLA-ELA AND MARIO O. SAN JUAN [2]

WITH ONE PLATE AND FIVE TEXT FIGURES

Leaf spot and stem rot are two forms of a disease of abacá (*Musa textilis* Née). The leaf spot form of the disease first appears as small, yellowish, then brownish, and finally black spots on the blade of the leaves. With age, the spots increase in size and coalesce to form extensive blotches. The stem rot form of the disease first appears as small, light-brown to brown lesions on the outer leaf sheaths of seedlings and mature abacá stems. The disease works inward, attacking one sheath after another.

The two forms of the disease are caused by *Helminthosporium torulosum* (Syd.) Ashby. The cells of the hyphae have an average size of 25.75 × 4.24μ on a 13-day culture of potato-dextrose agar. They are hyaline, granular when young, light olivaceous to dark olivaceous and vacuolate with age, branched, and septate. Submerged hyphae are swollen at the septa. The conidiophores are simple at first, increasing in diameter towards the apex and terminating in a swollen head from which one conidium buds out. They continue to grow before or after the conidium is detached and form long necklacelike, occasionally branched chains of conidiophores at the tip of the last cell. The average size of the conidiophores in culture is 135.88μ × 6.33μ, and the average diameter of heads is 11.90μ. The conidia are oval, mostly conical or obclavate, broad below and tapering to a blunt end, or long, slender, and curved, hyaline to dark olivaceous with age. They are usually four- to five-septate, somewhat thick-walled, and granular to vacuolate. On infected leaves and stems of abacá in the field the conidia have an average size of 49.83 × 15.44μ, and on a 13-day-old culture, 63.43 × 16.72μ. The fungus produces good growth and abundant spores on potato-dextrose agar with pH values from 5.2 to 7.8.

The fungus remains viable for 6 to 12 months in the laboratory. In the field it tides over adverse conditions as mycelium. It is capable of direct penetration. Leaf and stem infections are prevalent and severe in June, July, August, September, and October when the weather is warm and moist. The conidia are disseminated by wind and rain water. Stem rot and leaf spot injuries may be minimized by field sanitation, timely harvest of mature plants, and proper distancing.

In June, 1952, severe spotting of the leaves and rotting of the stems of abacá (*Musa textilis* Née) plants and seedlings occurred in the abacá experimental plot of the Department of Plant Pathology, College of Agriculture, Los Baños, Laguna. The writers first attributed the phenomena to unthrifty growth of the plants, the effect of a drought followed by unusual rains, and the mosaic disease. Microscoopic examinations of diseased leaves and stems, however, revealed conidiophores and conidia of a *Helminthosporium*. As the leaf spot of abacá has not hitherto been reported in the Philippines. the disease was studied to compare its causal fungus with the stem

[1] Central Experiment Station Contribution No. 1780.

[2] The writers thank Dr. G. O. Ocfemia for advice and criticism during the progress of the work and the preparation of the manuscript.

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rot organism, *Helminthosporium torulosum* (Syd.) Ashby, reported by Calinisan, Agati, and Aldaba (1931, 1934).

THE DISEASE

History, distribution, and economic importance

The stem rot of abacá was first observed by Calinisan, Agati, and Aldaba (1931) in 1927 in the abacá experiment stations in Silang, Cavite, and in 1931 in Davao and in Guinobatan, Albay. These authors reported that the rot was confined to the stem of abacá.

The spots caused by the disease on the leaves, though few in number, enlarge and weaken the plants. The stem rot form of the disease readily causes the death of four- to six-month-old seedlings, and severe infections render the sheaths composing the stems of mature plants unfit for stripping. The two forms of the disease, however, are of minor economic importance.

Symptoms

On the leaves. Leaf spot of abacá first manifests itself as small pinpoints which are yellowish, then brownish, and finally black on the blade of the leaves. Some of the spots may occur on the concavity of the midrib and on the petioles. In the field these spots are few and can be mistaken for anthracnose lesions. The lesions of the leaf spot disease, however, increase in size, faster in length than in width, and finally form blotches of varying sizes which sometimes run the length of the blade. Small and large blotches are surrounded by yellowed areas. The writers noted that the larger spots or blotches, which Agati (1925) regarded as anthracnose of abacá, are caused by *Helminthosporium torulosum*. The black color of the spots changes, and fully developed lesions become brown and dry; the original small, black spots remain distinct. The spots surrounded by bright yellow borders vary in size from 1 to 85 mm. or more in length and from 1 to 43 mm. or more in width. They appear more or less zonated because of the successive changes in color and increases in size. The spots along the margin and midrib of the leaves become more or less fan-shaped (fig. 1, upper panel). The spots on the cavity of the midrib and on the petioles do not enlarge much.

In the greenhouse the spots on the leaves are black, somewhat water-soaked, and surrounded by a bright yellow area. They progress rapidly, finally drying up and turning brown with yellow borders.

On the stem. The fungus attacks the stems of abacá in all stages of growth. The disease on the stem is more severe than on the leaves. Small, light- to dark-brown lesions surrounded by lighter brown areas are produced on the outer leaf sheaths of mature plants and seedlings. Two or more neighboring spots coalesce and form large oval to oblong spots. These spots continue to enlarge and turn

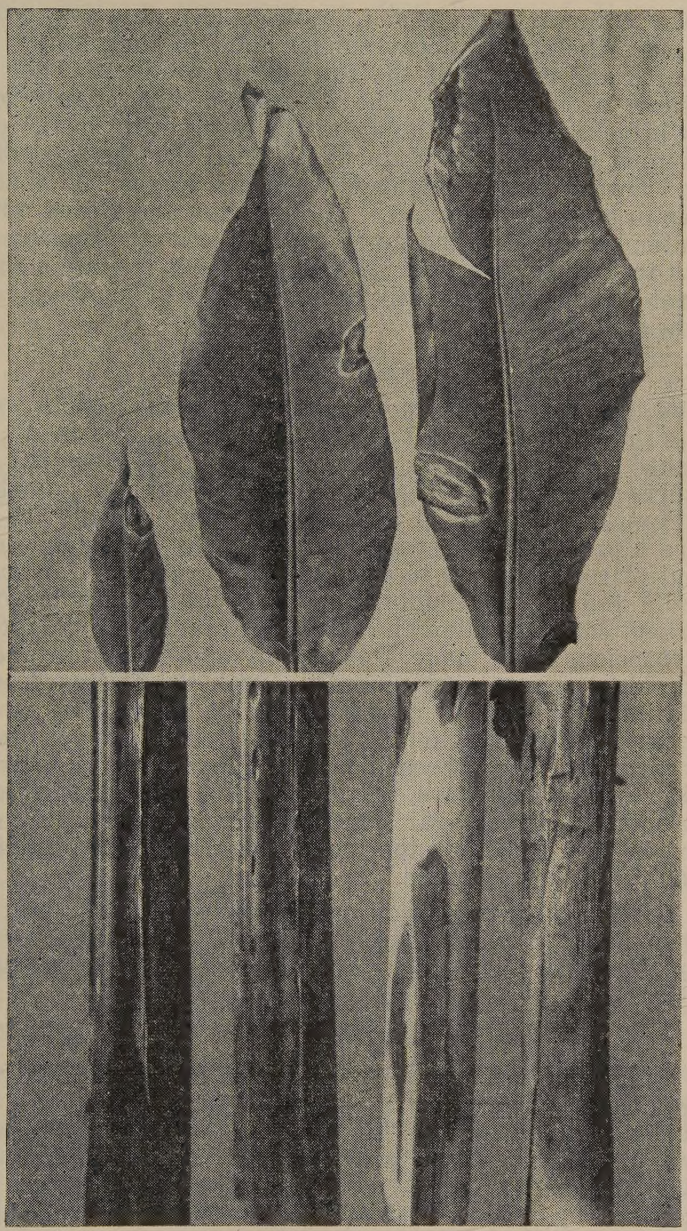

Fig. 1.—Upper panel, leaves of abacá seedlings showing the typical symptoms of leaf spot along the margin. Lower panel, portions of abacá stems showing symptoms of stem rot disease.

dark brown to almost black (fig. 1, lower panel). In advanced stages of the disease the spots appear sunken, and in their inner regions conidiophores and conidia of the fungus are produced when weather conditions are favorable. The disease on the stem works inward. It attacks one sheath after another, resulting in the girdling and weakening of the abacá stem. Weakened sheaths are not fit for stripping. Owing to the weight of the green leaves, the abacá stem bends over in a severe infection. The infected and rotted outer leaf sheaths later become dry and curl in all directions, exposing the innor sheath to further infection. Further rotting results in the death of the plant. The disease readily causes death of four- to six-month-old seedlings.

CAUSAL ORGANISM

Sections from the inner portions of the typical spots were disinfected with 1:1000 mercuric bichloride solution for 30 to 45 seconds, washed in three changes of sterile distilled water, and planted on the surface of congealed potato-dextrose agar in sterile Petri dishes. Portions of infected abacá leaves and stems with typical spots were also disinfected, washed thoroughly with sterile distilled water, and placed for three to four days in large Petri dishes. The dishes had a diameter of 180 mm. and were lined at the bottom with wet absorbent cotton to allow the fungus to produce abundant spores. Spore suspensions were made, followed by spore dilution and planting. Individual spores were picked up with the flattened end of a sterile platinum needle and planted in small holes made on the solidified potato-dextrose agar in another sterile Petri dish. Four spores were transferred to each plate. When the fungous growth appeared in two to three days, transfers and subcultures in test tubes of sterile potato-dextrose agar slants were made. The pure cultures were used in the studies of the morphology, cultural behavior, and pathogenicity of the organism.

The fungous growth on potato-dextrose agar is at first grayish white, then dark purplish black, and finally slate gray [3] when the surface of the slant is covered with the growth and the fungus begins to sporulate.

Taxonomy

The fungus of leaf spot and stem rot of abacá also produces black tip disease of banana in artificial inoculation. As will be pointed out subsequently, the Philippine fungus from abacá has close similarities to *Helminthosporium torulosum* (Syd.) Ashby (=*Brachysporium torulosum* Syd. = *Cercospora musarum* Ashby) which was described by Sydow (1909), Ashby (1913), and Wardlaw (1935).

The fungus *Helminthosporium torulosum* (Syd.) Ashby has a wide distribution on banana. It was first recorded by Sydow in 1909

[3] All color names were from Robert Ridgway's "Color Standards and Color Nomenclature," Washington, D.C., 1912, 42 pp.

as *Brachysporium torulosum* on dead leaves of *Musa sapientum* from Brazil. According to Ogilvie (1928), the fungus was described by S. F. Ashby as *Cercospora musarum* from the black spot of the leaves of Gros Michel banana in Jamaica. Ogilvie (1928) proved by inoculation that the *Cercospora musarum* was the cause of black tip or finger tip disease of the Cavendish banana (*Musa cavendishii* Lambert) in Bermuda. Abbott (1929) reported the same in Peru.

According to Wardlaw (1935), *Helminthosporium torulosum* was found on plantain leaves in Ceylon by Petch in 1916 and was collected by Bunting in 1917 on banana sucker in the Gold Coast. It was isolated from black tip disease of Cavendish and Lacatan varieties in 1931 and 1934 in Trinidad and was found on fruit spots and wound blemishes of the Gros Michel and other varieties. The fungus occurs in Italian Somaliland, Central Province, India, and Suriname. Reyes (1934) observed the banana black tip disease in the Philippines in 1932. Agati, Calinisan, and Aldaba (1934) reported that the fungus isolated from abacá and banana in the Philippines was identified as *Helminthosporium torulosum* (Syd.) Ashby by S. P. Wiltshire of the Imperial Mycological Institute.

The fungus *Brachysporium torulosum* Syd., described later as *Cercospora musarum* Ashby, was renamed *Helminthosporium torulosum* (Syd.) Ashby in 1928.[4]

Morphology

Mycelium. The hyphae are hyaline and granular when young, becoming light olivaceous and vacuolate with age. They are branched and septate. Submereged hyphae are swollen at the septa, but the aerial ones are smooth (Pl. I, fig. 1). Measurements of 200 cells of the hyphae of a 13-day-old culture showed that the lengths range from 5.25 to 56.00 μ, or an average of 25.74 μ, and the diameters, from 1.75 to 8.55 μ, or an average of 4.28 μ.

Conidiophores. On diseased abacá leaves, the conidiophores are produced on the surface of the central black portion of the lesions protruding through the epidermis. In culture they arise singly from the sides and tips of the fine hyphae.

The conidiophores are erect and simple at first, increasing in diameter towards the apex and terminating in a swollen head (Pl. I, figs. 2 and 3) on which one conidium buds out (Pl. I, figs. 4 and 5). The conidium at maturity either remains attached for a time or is detached immediately. While the conidium is still attached, the conidiophore continues to grow from the side of the head. After the conidium has been detached, the conidiophore grows through the tip of the head. The new growth increases in length and diameter,

[4] E. W. Mason, "Annotated Account of Fungi Received at the Imperial Bureau of Mycology," List II (Fasc. 1), Imperial Bureau of Mycology, Kew, Surrey, England.

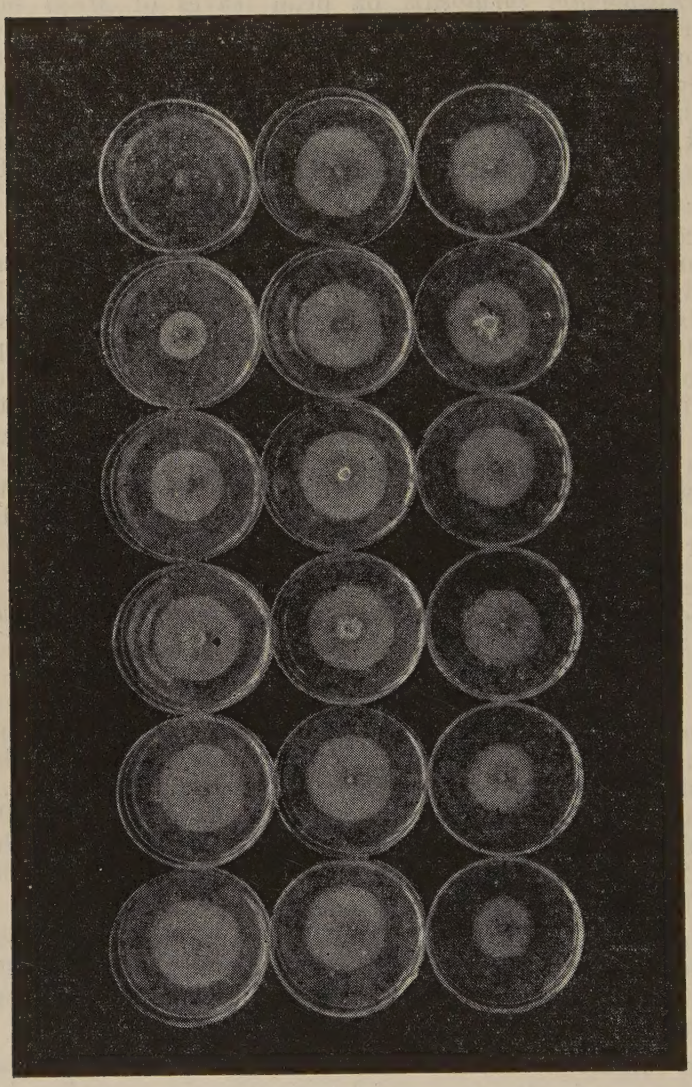

Fig. 2.—Plates showing growths of *Helminthosporium torulosum* (Syd.) Ashby on agar with pH values ranging from 2.8 to 8.8.

though some remain short, terminating in swollen, roundish heads. Occasionally, two conidiophores arise from one head. The newly formed conidiophore either produces a conidium at its tip or continues to grow into a long, fully developed chain of conidiophores with as many as 25 or more heads. A conidium is soon produced at the tip of each conidiophore. The conidiophores can easily be dis-

tinguished from the hyphae that produce them by their position, shape, and light olivaceous to dark olivaceous color which becomes darker towards the head even at an early age.

Measurements of 200 conidiophores from a 13-day-old culture showed that the lengths range from 28.00 to 367.50 μ, or an average of 135.88 μ; the diameters, from 5.25 to 8.75 μ, or an average of 6.33 μ; and the diameters of the heads, from 7.00 to 14.00 μ, or an average of 11.90 μ.

Conidia. The conidia are produced at the tip of the conidiophores in the central portion of the lesions. They are abundant in culture on most of the media used. They are formed by budding usually at the tip and sometimes at the side of the heads of conidiophores; only one conidium is produced on one head. The young conidia are small, hyaline, round at first, then oval, granular, and nonseptate. Later they enlarge, become elongate, and develop septa ranging from 1 to 17; the majority have 4 to 5 septa. At the beginning one septum is usually produced near the apical end. Most of the conidia remain straight, stout, conidial, obclavate, and tapering to a blunt end. Some conidia are long, slender, and curved; a few spores are oval in shape. Mature conidia are dark olivaceous or smoky brown, somewhat thick-walled, and vacuolate. Each conidium has a prominent round disc at the base which marks its point of attachment to the swollen conidiophore head (Pl. I, figs. 6 and 7).

Measurements of 400 conidia, 200 from infected leaves and stems in the field and 200 from a 13-day-old culture on potato-dextrose agar (table 1), were distributed in classes made by a difference of 6 μ. The lengths of the conidia from the culture fell in classes between 27.5 to 33.49 μ and 135.5 to 141.49 μ, and the widths, between 3.5 to 9.49 μ and 21.5 to 27.49 μ. The greatest number of the conidia from the culture had lengths in class 57.5 to 63.49 μ and widths in class 15.5 to 21.49 μ. The average size of the 200 conidia from a 13-day-old pure culture was 63.34 × 16.72 μ. Longer but narrower conidia whose measurements are not included above observed from older cultures had an average size of 122.66 × 15.45 μ.

The greatest number of the conidia from field material had lengths in class 45.50 to 51.49 μ and widths in class 15.5 to 21.49 μ (figs. 3 and 4). The average size of 200 conidia from field material was 49.83 × 15.44 μ. As was expected, the spores produced by the 13-day-old culture in the laboratory were longer and wider than those produced in the field.

Ratios of length to width of conidia

The ratios of length to width of 400 conidia were distributed in classes made by a difference of 1.09 μ (table 2 and fig. 5). The greatest number of conidia from pure culture and from specimens in the field had a ratio of 3.05 to 4.14. The average ratio of 200 conidia from pure culture was 3.83, and that of 200 from field material was 3.18.

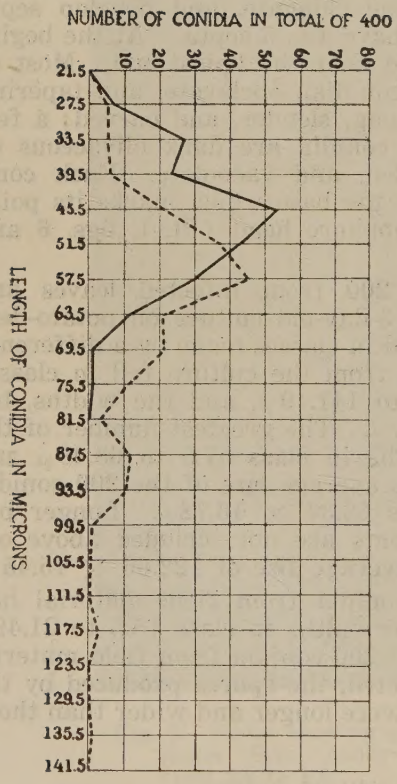

Fig. 3.—Variation in length of conidia of *Helminthosporium torulosum* (Syd.) Ashby taken from the host and from a 13-day culture.
— = variation in length of the conidia from the host.
.... = variation in length of the conidia from the culture.

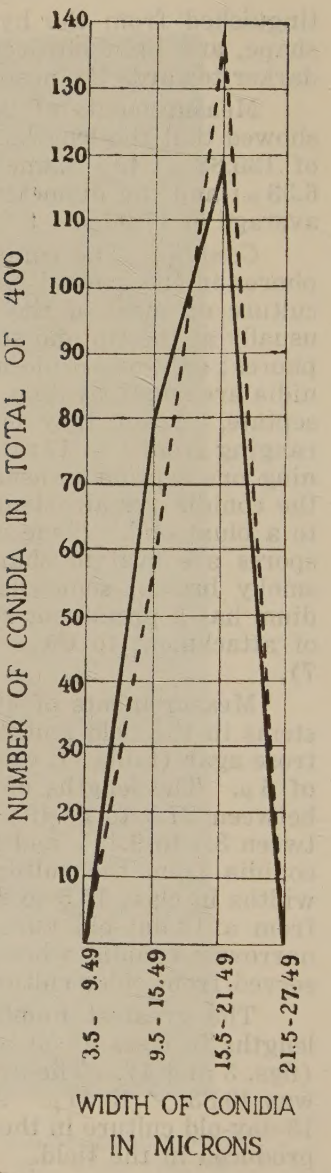

Fig. 4.—Variation in width of conidia of *Helminthosporium* torulosum (Syd.) Ashby taken from the host and from a 13-day culture.
— = variation in width of the conidia from the host.
.... = variation in width of the conidia from the culture.

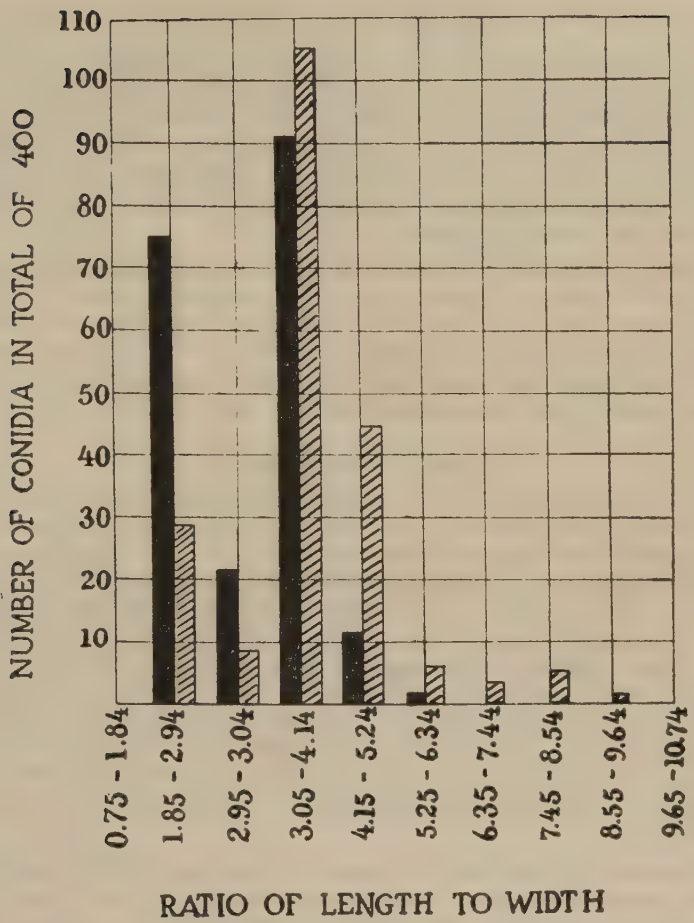

Fig. 5.—Arrangement in classes of the ratios of length to width of conidia of *Helminthosporium torulosum* (Syd.) Ashby showing the limits of variation.
■ —ratios of length to width of conidia from the host.
▨ —ratios of length to width of conidia from a 13-day culture

Growth and conidial production on different substrates

The growth and conidial production of the Philippine *Helminthosporium torulosum* isolated from abacá were studied on potato-dextrose agar, oatmeal agar, corn meal agar, rice decoction agar, water agar, nutrient agar, corn decoction agar, onion agar, abacá stem, potato plug, starch agar, and abacá leaf. The amount and color of the growths and spore production (table 3) varied on the different substrates.

Effects of varying hydrogen-ion concentrations on the growth and conidial production of the fungus

The influence of the hydrogen-ion concentration on growth and conidial production of the fungus was studied on 10 cc. triplicate cultures on potato-dextrose agar. The pH was adjusted to range from 2.6 to 9.6, using a La Motte colorimeter and sterilized N/20 HCl or N/20 NaOH. The contents of each test tube of the agar with the adjusted pH were poured into a sterile Petri dish, spread evenly, and allowed to congeal.

Uniform bits of the fungous growth were planted in Petri dishes, one in the center of each plate. The cultures were incubated at room temperature of 27° to 28°C., and the daily growths of the fungus for six days were measured. Table 4a and figure 2 show the extent of the growths, and table 4b shows the color of the growths and the quantity of spores produced.

Germination of conidia

On January 31, 1953, conidia from pure culture and from infected leaves and stems of the host were germinated in tap water, sterile distilled water, and nutrient broth in van Tieghem cells and on nutrient agar and potato-dextrose agar blocks at a laboratory temperature of 27° to 28°C. The first sign of germination was the production of a slight protuberance usually at the apical end of the conidium. This protuberance soon developed into a germ tube. The conidia produced from one to two germ tubes from one or both ends after two hours (Pl. I, fig. 8). Germination by the production of a single germ tube from either the basal or the apical cell, usually from the latter, was the most frequent. Atypical germination by the production of one or more germ tubes from any intermediate cell also occurred.

The conidia germinated faster in nutrient broth, nutrient agar, and potato-dextrose agar than in tap water and sterile distilled water. After 24 hours, most of the germinating spores had long, branched, septate, hyaline, and granular infection hyphae. Some conidia produced conidiophores on which secondary conidia began to form at the tip of the swollen heads six hours after germination (Pl. I, fig. 9). The germinating conidia in van Tieghem cells did not produce appressoria. Spore suspension placed with a sterile loop on the surface of young furled leaves of abacá or banana produced appressoria for attachment to the host (Pl. I, figs. 10 and 11).

Viability of the fungus

Plate and test tube cultures of the fungus were placed in the laboratory at room temperature of 27° and 28°C. on February 2, 1953, and the conidia were germinated in nutrient broth in van Tieghem cells at monthly intervals. Transfers were also made monthly on fresh potato-dextrose agar slants. The fungus remained viable on the medium in the Petri dishes for six months. It remained via-

ble in the test tubes for six months longer because the medium dried more slowly in the test tubes than in the Petri dishes. When hot, liquefied, sterile potato-dextrose agar was poured aseptically into the test tubes with old, dry culture, abundant mycelium and conidia were again observed after one week, indicating that the fungus retains its viability for six to twelve months. Growth stopped when the medium dried up; the fungus was revived when fresh medium was added. Although no work was done to determine how the fungus tides over the dry period in the field, it appears that the mycelium can stand dessication and resume growth when the wet weather sets in.

Pathogenicity

To test the pathogenicity of *H. torulosum* isolated from abacá leaves and stems, 13-day cultures were inoculated by atomizing spore suspension on injured and uninjured plants, by placing bits of fungous growth on wounded and unwounded parts, and by smearing the spore suspension on the plants after removing the bloom covering the parts to be inoculated.

Experiment 1. On September 8, 1952, four healthy, four-month-old abacá seedlings were sprayed with a spore suspension of the fungus. Four other healthy seedlings of the same age were sprayed with sterile distilled water for control. The inoculated and check plants were placed in the damp chamber for five to six days. After two days, small spots appeared on the leaves; four to five days later, some appeared on the stems. The control plants were not infected. After six days both the check and the experimental plants were placed outside in the shade for further observation. In less than a month, big spots similar to those reported on banana leaves were produced. Those on the stems also became bigger and later caused the death of the experimental plants. The fungus was reisolated and used for inoculating another set of seedlings.

Experiment 2. On October 27, 1952, four healthy, five-month-old abacá seedlings were sprayed with spore suspension on leaves and leaf sheaths pricked with mounted sterile needles. Four unpricked plants were also sprayed. The control plants for both methods of inoculation were sprayed with sterile distilled water. The experimental and check plants were placed in the damp chamber for one week. In two to four days infection was noted on the experimental plants of the two sets, especially on the pricked plants. The control plants did not develop spots. Both sets were placed in the shade outside for further observation. In about one month, the inoculated plants died of stem rot. The fungus was reisolated and used for another inoculation work.

Experiment 3. On January 15, 1953, four eight-month-old, healthy abacá plants were inoculated by placing bits of fungous growth on wounded and unwounded parts of the leaves and stems, which were then covered with wet absorbent cotton. Pricked and

unpricked stalks of mature plants were also inoculated. The control plants were inoculated with pieces of sterile potato-dextrose agar on the wounded and unwounded parts. In two to four days infection more severe than in experiment 2 was noted on the inoculated plants. After one week, both the check and control plants were placed outside for further observation. Some of the spots on the leaves became big and there was serious rotting of the stems. The results show that the fungus is capable of infecting abacá with or without wounds. The fungus was recovered, and the reisolate was used for inoculating other abacá plants.

Experiment 4. Healthy plants of canna (*Canna indica* Linn.), abacá, Lacatan, Buñgulan, Inarnibal and Cavendish varieties of banana, cogon (*Imperata cylindrica* [Linn.] Beauv. var. Koenigi [Retz.] Bent.), and corn were sprayed on October 18, 1953, with spore suspension of the fungus. The control plants were sprayed with sterile distilled water. Both the experimental and check plants were placed in the damp chamber for a week. On October 21, 1953, infection was noted on abacá and on Lacatan, Cavendish, Bungulan, and Inarnibal bananas but not on canna, cogon, and corn. The plants were placed outside for further observation. The fungus was reisolated from the typical spots on Lacatan and abacá for use in reinoculation.

Experiment 5. On January 3, 1954, bits of fungous growth were placed on small incisions near the tips of green detached fruits of different varieties of banana. The control fruits were also incised, but only small pieces of sterile potato-dextrose agar were placed on the incisions. Ogilvie (1928) used this method of inoculation to show that *Helminthosporium torulosum* is the cause of black tip disease of banana. All the inoculated fruits showed symptoms of rotting on the wounded parts. A careful examination, however, showed that only the skin was infected. The control did not show any infection; the wounds merely dried up.

Experiment 6. On January 22, 1954, experiment 4 was repeated on different varieties of banana, abacá, and canna. Lacatan, Cavendish, Buñgulan, Inarnibal, and abacá were infected; the degree of infection was in the order named. The lesions were at first small and scattered all over the blade and cavity of the midrib. The plants were placed outside for observation. Twenty days after inoculation, some spots had considerably increased in size and had become typical of *H. torulosum* infection.

Experiment 7. On February 1, 1954, following Stahel's (1924) method of inoculating banana leaf with *H. torulosum,* pieces of a young, newly unfurled leaf of banana and a very young furled leaf of abacá were wiped with wet cotton to remove the bloom and smeared with spore suspension of the fungus from abacá. They were placed in large Petri dishes with a diameter of 180 mm. and lined at the bottom with wet absorbent cotton. Twenty-four hours after

inoculation, numerous small, brownish spots with very light-yellow borders were visible on the upper surface of the leaves of both banana and abacá. Two or three days later, the spots grew larger, coalesced, and became bordered with yellowish areas visible on both surfaces of the leaves.

Varietal susceptibility of abacá

Itom and Pula varieties of abacá used in the inoculation experiments were readily attacked by the fungus producing lesions of leaf spot and stem rot. Calinisan, Agati, and Aldaba (1931) observed that varieties Buñgulanon, Balunan, Punucan, Sinamoro Puti, Tañgonon, Lawisid, Sinamoro Pula, Jolo, Maguindanao, Putian, Sinibuyas, and Kinalabao were attacked with varying degrees of infection. Buñgulanon, the most severely affected, had 48.86 per cent infection, and Kinalabao, the least affected, had 4.39 per cent infection.

When varieties Itom, Lausigon, and Tinauagan Pute [5] were inoculated, only Tinauagan Pute did not show symptoms of the disease. Work to determine the relative susceptibility of abacá varieties is still under way.

LIFE HISTORY OF HELMINTHOSPORIUM TORULOSUM (SYD.) ASHBY IN RELATION TO THE PRODUCTION OF THE DISEASE

Seasonal occurrence. The leaf spot and stem rot forms of the disease are more prevalent and severe during the rainy season when it is warm and moist. In Los Baños, the weather from the later part of June to the early part of October is favorable to the development of the fungus.

Source of inoculum and infection in the field. The parasite is present in the infected tissues of the host where it produces conidia. When the host dies or is cut down but left to rot in the plantation, the fungus lives as a saprophyte and may persist in the form of mycelium. As soon as weather conditions become favorable, the fungus grows and sporulates again. These spores become the source of primary infection.

Bananas, which are grown throughout the year and are hosts of the fungus, are also sources of inoculum. Wardlaw (1935) found the fungus as a saprophyte on leaves, transition leaves, bracts, and fruits of bananas.

Method of dissemination. The spread of the disease is effected to a considerable extent by conidia. Sporulation takes place when the weather is warm and moist. The conidia are easily detached from the conidiophores and are transported from one part of the plant to another by rain and wind.

Method of infection. Wounds on abacá and banana are not necessary for infection by *Helminthosporium torulosum*, although the

[5] Obtained through the courtesy of Mr. Carlos Calica of the Abacá Experiment Station in Banao, Guinobatan, Albay.

disease appears earlier and more readily on the wounded parts of the host. When a spore suspension of the fungus was smeared on the surface of young, newly unfurled leaves of abacá and banana (experiment 7), numerous, minute, brownish spots with very light-yellow borders were produced 24 hours after inoculation. Sections of the leaves were killed and decolorized with one part 95 per cent alcohol and one part glacial acetic acid and were placed on slides. When a few drops of lactophenol with cotton blue stain were added the germ tubes were seen to begin to enter directly through the epidermis. At the end of each germ tube, an appressorium was produced prior to infection (Pl. I, fig. 10).

The epidermal and surrounding cells and the underlying water cells were killed and became reddish brown in color and granular in content (Pl. I, fig. 11). Stahel noted these changes and attributed the death and discoloration to diffusing toxic secretions of the fungus.

CONTROL MEASURES

Field sanitation. Since the fungus remains saprophytically on decaying plant parts in the plantation, diseased leaf sheaths and leaves should be removed and destroyed to reduce the sources of inoculum. Wardlaw (1935) recommended a similar measure for black spot of banana.

Timely harvest of abacá. According to Santos [6] some abacá stalks begin to mature and are ready for harvesting and stripping from the eighteenth month after planting. Harvesting the large abacá plants before the rot becomes severe will help reduce losses from the disease.

Proper distancing. The leaf spot and stem rot forms of the disease of abacá spread rapidly in crowded fields during the wet season. Proper distancing will help prevent some plants from getting the disease. Santos [7] recommended planting abacá at least three meters apart each way in straight rows on level ground and according to the contour of the land on hillsides. With such a distancing the plants will have ample space to develop fully and vigorously and, hence, become less subject to the attack of the fungus.

Use of fungicides. Spraying with Bordeaux mixture 3-5-50 as soon as the first sign of spotting and rotting appears and repeating the process as new growths are noted will greatly help protect abacá plants. According to Ashby (1913), the best treatment for leaf spot of banana is timely application of Bordeaux mixture as soon as the first sign of spotting appears.

From January 17 to 20, 1953, the writers tested the effectiveness of Fermate by growing the fungus on potato-dextrose agar in Petri dishes and adding 1 cc. of 0.2 per cent, 0.3 per cent, 0.4 per

[6] Jose B. Santos, *Agric. & Indus. Life*, **16**, 1(1954).
[7] *Ibid.*

cent, 0.7 per cent, 1.5 per cent, and 2.0 per cent of the fungicide in solution to every 10 cc. of the medium. For every three Petri dishes of each concentration, three other Petri dishes without Fermate were used as control. In all the Petri dishes to which Fermate had been added, no growth of the fungus was observed, but in the Petri dishes without the fungicide, the growth was profuse and dense. This experiment merits trial in the field.

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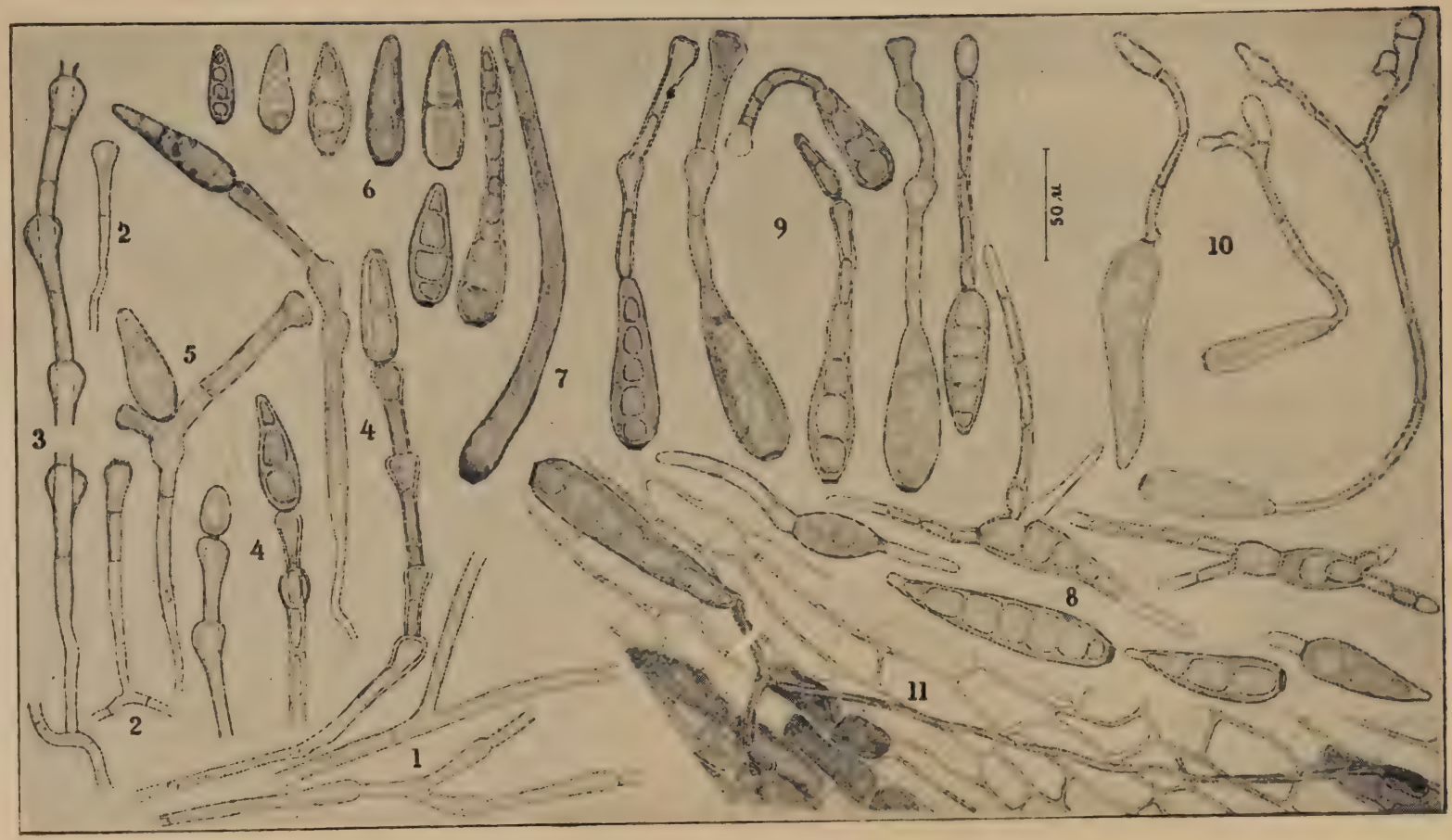
DESCRIPTION OF PLATE I

1.—Smooth and inflated hyphae of *H. torulosum* (Syd.) Ashby.
2.—Young, simple conidiophores of *H. torulosum* (Syd.) Ashby.
3.—A conidiophore with four heads.
4.—Conidiophore producing conidium at the tip of the head; only one conidium is produced on one head.
5.—Conidiophore producing another conidiophore at the side or tip of the head before or after the conidium is detached.
6.—Straight, stout, conical, obclavate conidia of *H. torulosum* (Syd.) Ashby.
7.—The long, slender, curved type of conidia produced occasionally.
8.—Conidia germinating on liquid and agar media by the production of one or more germ tubes from one or both ends and, occasionally, from the intermediate cell.
9.—Conidia producing conidiophores which in turn produce conidia six hours after germination.
10.—Conidia producing appressoria at the end of the tubes prior to infection. They were taken from the surface of infected young leaves.
11.—Infection by the germinating spore of *H. torulosum* (Syd.) Ashby showing appressoria, epidermal cells, and underlying water cells which had been killed and discolored by the toxic secretion of the fungus.



MENDIOLA-ELA AND SAN JUAN: LEAF SPOT AND STEM ROT OF ABACA

TABLE 1

Distribution of the lengths and widths of conidia of Helminthosporium torulosum (Syd.) Ashby in classes made by a difference of 6 microns

LENGTH CLASS IN MICRONS	CONIDIA FROM		WIDTH CLASS IN MICRONS	CONIDIA FROM	
	Host	Culture		Host	Culture
—	—	—	3.5–9.49	1	—
—	—	—	9.5–15.49	80	58
—	—	—	15.5–21.49	119	139
—	—	—	21.5–27.49	0	3
—	7	6	—	—	—
27.5–33.49	27	5	—	—	—
33.5–39.49	24	6	—	—	—
39.5–45.49	54	21	—	—	—
45.5–51.49	43	37	—	—	—
51.5–57.49	30	46	—	—	—
57.5–63.49	11	21	—	—	—
63.5–69.49	2	22	—	—	—
69.5–75.49	2	12	—	—	—
75.5–81.49	0	4	—	—	—
81.5–87.49	0	11	—	—	—
87.5–93.49	0	1	—	—	—
93.5–99.49	0	2	—	—	—
99.5–105.49	0	1	—	—	—
105.5–111.49	0	1	—	—	—
111.5–117.49	0	3	—	—	—
117.5–123.49	0	0	—	—	—
123.5–129.49	0	0	—	—	—
129.5–135.49	0	0	—	—	—
135.5–141.49	0	1	—	—	—
141.5–147.49	0	0	—	—	—

TABLE 2

Ratios of length to width of 400 conidia of Helminthosporium torulosum (Syd.) Ashby distributed in classes made by a difference of 1.09 microns

RATIO CLASS IN MICRONS	NUMBER OF CONIDIA	
	200 from culture	200 from field material
1.85–2.94	29	75
2.95–3.04	9	22
3.05–4.14	105	91
4.15–5 24	44	11
5.25–6.34	6	1
6.35–7.44	2	0
7.45–8.54	4	0
8.55–9.64	1	0
9.65–10.74	0	0

TABLE 3

Growth characteristics and conidial production of Helminthosporium torulosum (Syd.) Ashby on various agar media and sterilized plant tissues

MEDIUM	GROWTH CHARACTERISTIC	PRODUCTION OF CONIDIA	DIAMETER OF GROWTH AFTER 6 DAYS	AVERAGE DAILY GROWTH
			mm.	*mm.*
Potato-dextrose agar	Dense and fluffy, grayish white to dark purplish gray and finally slate gray	Abundant	85.00	14.17
Oatmeal agar	Dense and fluffy, grayish white to slate gray	Abundant	75.00	12.50
Corn meal agar	Moderate and fluffy, grayish white to light neutral gray	Moderately abundant	70.00	11.66
Rice decoction agar	Moderate, grayish white to light neutral gray	Moderately abundant	71.66	11.94
Water agar	Moderate and fluffy, gray	None	45.00	7.50
Nutrient agar	Dense, fluffy, grayish white to slate gray	Abundant	58.00	9.66
Corn decoction agar	Moderate, grayish white to slightly neutral gray	Moderately abundant	82.5	13.75
Onion agar [a]	Dense and fluffy, grayish white to slate gray	Abundant	—	—
Abacá stem [a]	Dense, fine, grayish white to slate gray	Abundant	—	—
Potato plug [a]	Dense and fluffy, grayish white to slate gray	Abundant	—	—
Starch agar [a]	Moderate, fluffy, grayish white to dull gray then slate gray	Moderately abundant	—	—
Abacá leaf [a]	Dense and fine, grayish white to slightly neutral gray and finally slate gray	Abundant	—	—

[a] The fungus was grown on the medium in test tubes; hence, no measurement was made.

TABLE 4a

Influence of hydrogen-ion concentration on the growth of Helminthosporium torulosum (Syd.) Ashby

pH	AVERAGE GROWTH IN THE THREE PLATES, IN mm., AFTER					AVERAGE GROWTH IN THE FIVE READINGS
	2 days	3 days	5 days	6 days	7 days	
2.6	0	0	0	0	0	0
2.8	0	0	0	0	0	0
3.0	1.00	1.33	2.00	10.00	15.00	7.33
3.4	5.66	9.66	18.00	23.00	30.00	17.33
4.2	10.00	18.66	37.00	44.00	61.00	34.13
5.2	11.66	25.66	52.33	67.50	80.00	47.43
5.4	12.66	27.00	53.33	67.50	80.00	48.10
5.8	12.33	27.00	53.33	67.50	80.00	48.03
6.0	14.00	27.00	53.66	67.66	80.00	48.46
6.4	14.33	26.66	52.00	67.00	80.00	48.00
6.8	14.66	26.00	49.00	66.00	80.00	47.13
7.0	16.66	26.00	45.00	65.66	75.00	45.66
7.2	15.00	23.33	40.00	57.00	66.00	40.26
7.4	14.00	21.00	38.50	56.50	65.66	39.13
7.6	14.00	21.00	38.00	56.50	65.00	38.90
7.8	12.33	20.66	37.66	54.00	65.00	37.93
8.2	10.33	18.00	32.66	53.00	60.00	33.60
8.4	10.00	14.00	32.00	52.00	60.00	35.60
8.8	11.00	18.66	32.00	51.00	58.00	33.19
9.2	8.00	19.00	32.00	51.00	58.00	33.60
9.6	8.00	16.00	32.00	47.70	56.00	31.94

TABLE 4b

Effect of different hydrogen-ion concentrations upon the color of growth and production of spores of Helminthosporium torulosum (Syd.) Ashby

pH OF MEDIUM	FUNGUS AT 10 DAYS OF AGE
2.0	No growth; no spores
2.6	No growth; no spores
3.0	Growth little; white to mouse gray; spores moderate
3.4	Growth thin; mouse gray; spores moderate
4.2	Growth moderate; dark olive-gray; spores abundant, stout, and short
5.2	Growth thick, fluffy; dusky green-gray; spores abundant, stout, and short
5.4	Growth thick; dusky green-gray; spores abundant, stout, and short
5.8	Growth thick; dusky green-gray; spores abundant, short, and stout
6.0	Growth thick; dusky green-gray; spores abundant, short, and stout
6.8	Growth moderate; dark olive-gray; spores abundant, stout, and slender; 2- to 12-septate
7.6	Growth moderate; dark olive-gray; spores abundant, mostly slender and curved; 2- to 17-septate
8.2	Growth moderate; castor gray; spores abundant, mostly slender; 2- to 14-septate
8.4	Growth moderate; storm gray; spores abundant, mostly slender
8.8	Growth moderately thin; castor gray; spores abundant, mostly slender

FENCE POST PRESERVATIVES AGAINST SUBTERRANEAN TERMITES [1]

GETULIO B. VIADO

WITH FIVE TEXT FIGURES

DDT was found to be the most effective preservative against termite damage on 100 fence posts of ipil-ipil, *Leucaena glauca* (Linn.) Benth. The number of posts damaged underground was 9 in the DDT lot, 13 in the pentachlorophenol lot, 16 in the benzene hexachloride lot, 19 in the asphalt lot, and 20 in the kerosene lot, the control; at ground level, the figures were 15, 17, 19, 20, and 20. All the posts were damaged above the ground. Pentachlorophenol was the only chemical which prevented the disintegration of the treated posts, although the treatment was not effective enough to prevent termite damage. Only pentachlorophenol exhibited some fungicidal effect, but only for a relatively short duration. Asphalt offered very little resistance to termite attack. Kerosene had no effect on the termites; the kerosene-treated posts were the first to be attacked in the entire lot.

One serious drawback in the use of wooden fence posts in the Philippines is that they rapidly disintegrate from the attacks of ground-inhabiting termites. Different species of wood vary widely in their resistance to termite attacks; relatively resistant species, however, are too expensive to use for ordinary fence posts. The most common species used in the vicinity is the ipil-ipil, *Leucaena glauca* (Linn.) Benth, which is so susceptible to termites that fence posts made of this wood require frequent change.

The treatment of fence posts with preservatives against soil-borne termites is not yet a general practice in the Philippines. This may be attributed to lack of adequate information on the subject or to the unavailability of suitable preservatives. Pangga (1937) found that common salt, coal tar, and Paris green are generally effective in preventing ground-inhabiting termites from attacking wooden and bamboo posts. He found salt to be the best preservative, followed by Paris green and then coal tar.

The discovery of more effective insecticides has given impetus to the work on the possible use of these substances to prevent termites from attacking wooden posts. Among those who have worked on this subject in other countries are Hatfield (1944), St. George (1944), Wilford (1944),[2] Wolcott (1944, 1945a, 1945b, 1945c, 1947, 1949, 1951), Coaton (1945), Dews and Morrill, Jr. (1946), Kelsey (1946), Hicock and Olson (1947), Petty (1948), Hetrick (1950), and Van der Laan (1951).

The present study was conducted at the Faculty Hill, UP College of Agriculture, to determine the efficiency of four chemicals in pre-

[1] Central Experiment Station Contribution No. 1781.
[2] B. H. Wilford, *USDA Cir.*, 717 (1944).

serving wooden fence posts from the attack of soil-inhabiting termites. The work covered the period from January, 1952, to February, 1954.

MATERIALS AND METHODS

One hundred ipil-ipil posts [3] ranging in diameter from 3.8 to 10.5 centimeters and in heartwood diameter from 0.0 to 5.6 centimeters were used in the investigation. The posts were 1 meter long, with a perpendicular cut at the base and a tangential or slanting cut at the end. The bark on the basal two-thirds of each post was removed completely. Bits of cambium left on the wood after the bark had been removed were scraped off. The posts were then partially dried in the open for two weeks before treatment. They were placed on bamboos laid on the ground to prevent their coming in contact with the soil.

The chemicals used were technical grades of DDT, benzene hexachloride (BHC) and pentachlorophenol (PCP) and asphalt. The asphalt was of the grade employed in road construction. Five per cent by weight kerosene solutions of the chemicals, except asphalt of which approximately one kilogram was dissolved in one liter kerosene, were prepared a few hours before treatment.

The posts were divided into five more or less uniform lots of twenty. Lot I was treated with DDT, lot II with BHC, lot III with pentachlorophenol, lot IV with asphalt, and lot V, the control, with kerosene. Lot V was treated first, followed by lots I, II, III, and IV.

The solution was placed in a small drum over a slow fire. The posts were held upright in the drum such that the lower two-thirds of each, from which the bark had been removed, was in the solution. The solution was heated below boiling temperature for 30 minutes, after which it was removed from the fire and left to cool for two hours. The posts were then removed from the solution and laid on their sides until the following day when they were set in the ground. During the treatment the solution was replenished from time to time to maintain its level. To minimize contamination of the chemicals, the drum was rinsed with kerosene before every treatment.

Holes 30 centimeters deep and 60 centimeters apart were dug with a post digger in a well-drained, slightly rolling area at Faculty Hill known to be infested with ground termites. The entire area was divided into two parts, each containing 50 holes. Ten posts were picked at random from each lot and set in the holes in each division in a randomized manner. A plan of the arrangement was made to avoid difficulty in identifying the posts throughout the test. The soil around each post was packed.

Periodic observations were made for the appearance of earthen exploratory tunnels on the posts. Except for occasional weeding when vines and other weeds began to cover them, the posts were not disturbed. Only two observations were made on the underground

[3] Most of the posts were supplied by the Department of Animal Husbandry.

portion of the posts, one at the end of the first year of the test and the other at the end of the second year, or at the close of the experiment. Frequent observations were not thought advisable because digging out the posts and resetting them after observation would remove at least part of the chemical on the surface of the wood and would disturb the already established termite connections.

For convenience in determining the location of damage on the posts, the portion buried two centimeters below the surface of the ground was termed "underground;" the portion about two centi- below and two centimeters above the ground was said to be at "ground level;" and the portion above ground level was termed "aboveground." The damage was considered slight when only a small portion of the wood was attacked, or when the depth of damage was less than one-fourth of the radius of the post; moderate when the depth was more than one-fourth but less than half the radius; and serious when the depth of damange was one-half or more of the radius. The post was considered disintegrated when all the portion aboveground had completely been devoured by termites, regardless of the portion underground. Many times, particularly, in the treated posts, at least part of the underground portion was still intact long after the portion above the ground had completely disintegrated.

DISCUSSION OF RESULTS

The most common soil-inhabiting termite destructive to wood involved in this test was the mound-building termite, *Macrotermes gilvus* (Hagen). Another species, *Microcerotermes losbañosensis* Oshima, was noted on three posts, one from the control lot, one from the lot treated with BHC, and one from the lot treated with asphalt. This species was first noted attacking the posts about fifteen months after the start of the experiment. *Coptotermes vastator* Light was not encountered in this test.

Twenty-four hours after the posts had been set in the ground, exploratory earthen tunnels were found on seven of the control posts. The number increased to 12 the following day; at the end of one week, tunnels were present on 17 of the 20 control posts. Nineteen days after the start of the experiment, tunnels were found on four of the posts treated with asphalt, but none were found on the posts treated with DDT, BHC, and PCP. Two weeks later, the number of posts with tunnels in the asphalt-treated lot increased to 10. Most of the tunnels in both the control and the asphalt-treated lots were temporary in nature; they contained no termite when examined. The first attempt of termites to construct tunnels in the other lots was noted 46 days after the start of the experiment, when one post in the BHC-treated lot was found to have a tunnel on it. This tunnel, however, did not reach the untreated portion of the post, and no termite was found in it. Two months after the start of the test, one post in the DDT lot, two in the PCP lot, and seven in the BHC lots had tunnels on them. After the first few rains in May, three months

after the start of the test, many of the treated posts had tunnels on them. However, close examination revealed that many of these tunnels contained no termites; the treated portion of the posts above the ground level was untouched, whereas the untreated end of many of them was damaged slightly.

Seventy of the posts used ranged in average diameter from 6.0 to 10.5 centimeters, and 30, from 3.8 to 5.9 centimeters. Thirteen of the 16 posts that disintegrated were the smallest in the entire lot, ranging in diameter from 3.8 to 5.3 centimeters, and had no heartwood. The remaining three had diameters of 6.0, 7.2, and 8.8 centimeters, with heartwood diameters of 4.0, 1.0, and 3.1 centimeters, respectively.

The results (table 1) show that on the basis of the number of posts that did not disintegrate during the test, the best preservative was PCP, followed by DDT, BHC, asphalt, and the control. The two posts that disintegrated in the DDT treatment were the smallest in that lot. Nine, or 45.0 per cent, of the posts in the DDT lot were damaged underground; 16, or 80.0 per cent, in the BHC lot; 13, or 65.0 per cent, in the PCP lot; 19, or 95.0 per cent, in the asphalt lot; and 20, or 100 per cent, in the control. At ground level 15, or 75.0 per cent, of the posts in the DDT lot were damaged; 19, or 95.0 per cent, in the BHC lot; 17, or 85.0 per cent, in the PCP lot; 20, or 100 per cent, in the control. One hundred per cent of all the treatments, including are control, was damaged above the ground.

The method employed in this study, although convenient to use on the farm, did not afford sufficient protection to the posts, probably because the hardness of the wood made it difficult for the chemicals to penetrate to a considerable depth. Treating the posts from the base to about one foot above the ground did not prevent the termites from constructing exploratory tunnels to reach the untreated portion. For better protection, the entire post should be treated after removal of the bark.

DDT. The DDT lot had the highest number of posts not damaged underground, at ground level, and aboveground at the close of the experiment, followed by the PCP, BHC, asphalt, and control lots (table 1). It is of interest to note that the underground portion of the two posts which were considered disintegrated appeared practically undamaged from the outside, but the inner portion was almost completely eaten up, leaving a shell of a few millimeters thick. Of the three posts which were seriously damaged underground, two were almost completely hollow inside, with the outer portion in contact with the soil still intact. The termites gained entrance into the lower portion of the posts at ground level. Apparently, they avoided the treated outer portion of the posts. In the third post the termites must have entered through a crack at the base, a portion of which was still visible at the time of examination.

In the first observation, the upper untreated one-third of the post was badly attacked by termites, whereas the treated middle

third above the ground was practically undamaged from the outside, indicating that the termites did not attack the treated portion although they used it as passageway to the untreated end of the post. At the close of the test, however, the treated portion above the ground of some of the posts was likewise attacked (fig. 1).

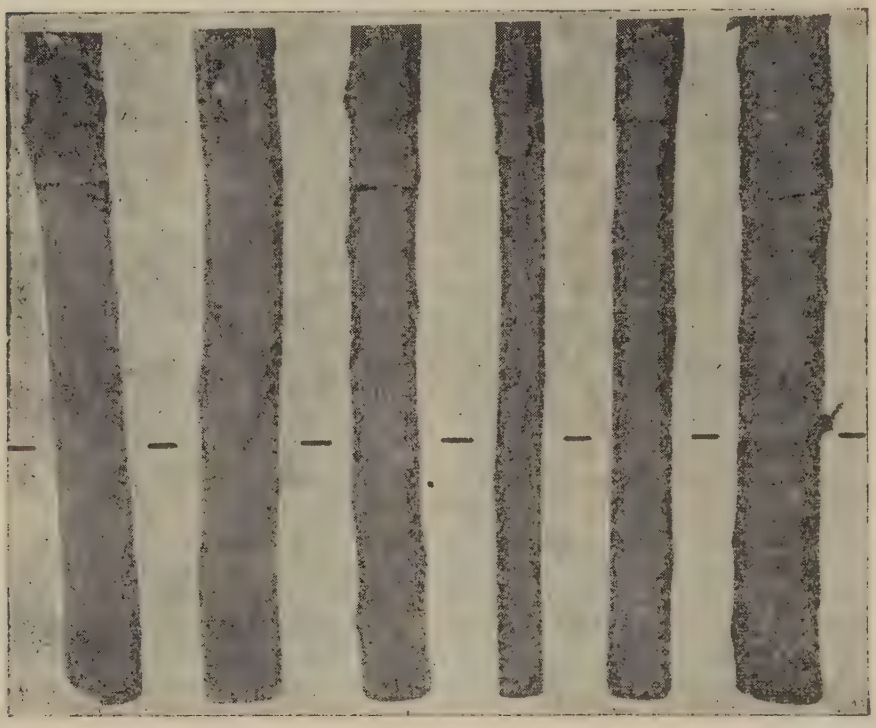


Fig. 1.—Posts from the DDT-treated lot at the conclusion of the test. The broken line across the figure indicates the ground level.

St. George (1944) found that small pine markers soaked in 1 or 5 per cent acetone solution of DDT for 18 hours and buried half their lengths in the ground were not attacked by *Reticulitermes flavipes* after four and one-half months, but tubes were built by the termites on the treated wood. Dew and Morrill, Jr. (1946), working at army installations in southeastern United States, showed that when wooden uprights and blocks for footings were soaked in a solution of 10 pounds DDT in 25 U.S. gallons diesel oil for 24 hours and when the holes and the soil used in covering them were sprayed, no termite approached the posts or went into the treated soil 16 months after treatment. Tests conducted in Indonesia by van der Laan (1951) indicated that boards immersed in 2 per cent DDT in benzene for one hour were not damaged by termites in the soil six months after they had been laid in the ground. This treatment was the best found by

van der Laan. When kerosene solution of DDT was applied at the rate of 3.6 milligrams per square foot on wood coated with enamel paint two years before it was sprayed, Petty (1948) noted that the treated wood was not attacked 24 hours after application but that the effectiveness of the treatment was nearly gone after a month. Of the three chemicals (DDT, BHC, and chlordan) he tested, DDT gave the best result.

For the control of drywood termite (*Kalotermes brevis* Walker), Wolcott (1944) found that wood impregnated with 1 per cent DDT in petroleum ether was very repellent and toxic to the insect for only a few weeks. He reported in 1945 that immersing 1 x ¼ x 1¼ inches samples of wood of *Bursera simaruba* for 10 minutes in 2 per cent DDT solution protected the wood from the nymphs of *Kalotermes brevis* for over a year. A 1 per cent treatment protected the wood for only 37 days. Two years later, he noted that the 2 per cent treatment continued to give protection to the wood for 33 months. In a later paper Wolcott (1949) stated that this same treatment protected the wood four to five years and that the wood could be considered permanently protected against termite attack. It may be of interest to mention in this connection that this investigator (1951) found that an analog of DDT (methoxychlor or methoxy-DDT) proved more effective than DDT against this species of drywood termite. Wood of *Poinciana* (*Delonix*) *regia* immersed for 10 minutes in a 0.05 per cent solution of the chemical protected the treated wood from attack for one year. Unfortunately, the writer was not able to secure a technical grade of this DDT analog so that it was not included in the present study.

BHC. The underground portion of the two posts in the BHC lot which were considered disintegrated was almost completely gone. No shell similar to that found in the DDT treatment was found. Of the five posts with underground parts seriously damaged, only one showed evidence that the termites had gained entrance into the lower portion of the post through the ground level. The rest were attacked below the ground.

In the first examination, the upper untreated one-third of the posts was attacked more than the lower treated third above the ground. At the end of the second year, however, the damage from the ground level to the top of the posts was more or less even (fig. 2).

The results (table 1) indicate that some amount of protection from termite attack was afforded by BHC to the posts, although the treatment was not as effective as DDT. When sprayed at the rate of 3.6 milligrams per square foot on wood freshly coated with distemper, gamma BHC was found by Petty (1948) to be more effective than DDT or chlordan applied at the same rate. Van der Laan (1951) found that boards immersed in 2 per cent hexachlorocyclohexane (BHC) suspension for one hour were more badly attacked than the untreated boards. When the suspension, however, was applied to the soil around the boards at the rate of 100 cc. to a board, little damage was noted after six months.

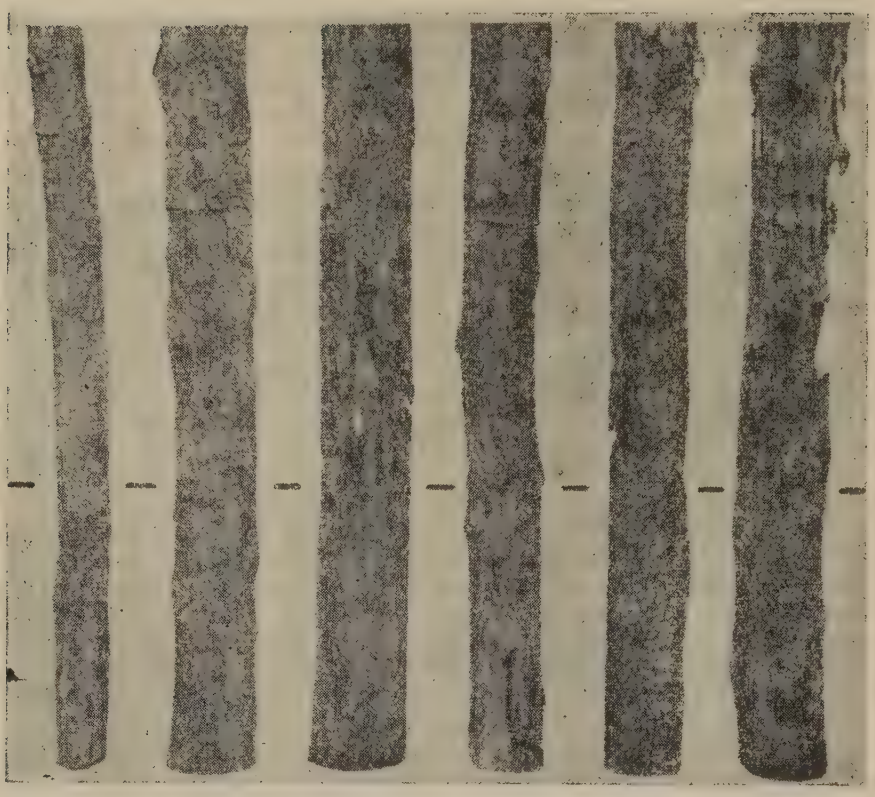


Fig. 2.—Posts from the BHC-treated lot at the conclusion of the test. The broken line across the figure indicates the ground level.

PCP. PCP was the only chemical among those studied which prevented disintegration of all the treated posts (table 1). The treatment, however, did not prevent termites from inflicting damage on the posts. The number of damaged posts in this treatment was lower than that in the BHC treatment but higher than that in the DDT treatment. Although the termites attacked first the untreated portion of the posts, the damage later on extended to the treated middle third, which was as badly damaged as the untreated portion at the end of two years (fig. 3).

The use of pentachlorophenol as a wood preservative against drywood termites has been the subject of research of some investigators. Wolcott (1944) found that wood impregnated with a 2 per cent solution of a proprietary product containing 5 per cent pentachlorophenol was not attacked by the West Indian drywood termite. He also observed that wood treated with 5 per cent pentachlorophenol in petroleum ether was not attacked after many weeks. In a later paper Wolcott (1945) reported that 1 per cent solution of penta-

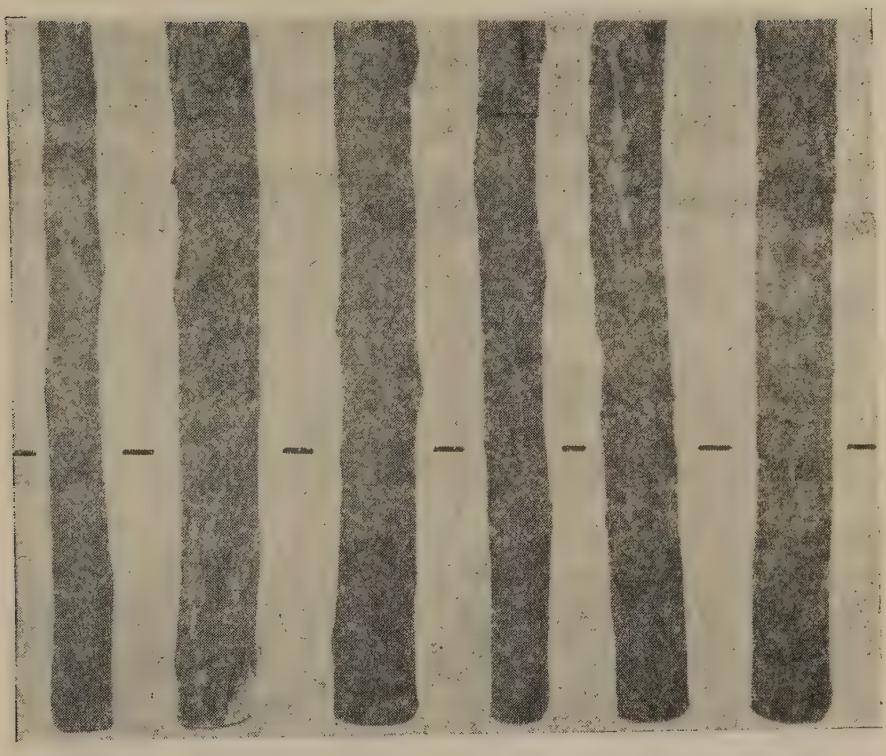


Fig. 3.—Posts from the PCP-treated lot at the conclusion of the tests. The broken line across the figure indicates the ground level.

chlorophenol gave protection for 337 days to susceptible woods in Porto Rico. A 0.5 per cent solution protected the wood for only 273 days. The results of a recent investigation (Wolcott, 1949), however, showed that wood immersed in 2 per cent solution of pentachlorophenol for 10 minutes afforded four to five years protection and that the treatment could be said to give permanent protection against drywood termite attack. Coaton (1948) stated that 5 per cent pentachlorophenol in white spirit with auxiliary solvent applied as power spray gave excellent control of *Kalotermes brevis* already established in the sapwoods, but that the treatment did not affect established colonies in other types of wood.

Asphalt. Asphalt was the poorest of the four chemicals tested. When the remnants of the underground portion of the five posts which disintegrated in this treatment were dug, it was found that practically nothing was left of three posts. None of the posts whose underground portion was seriously attacked by termites showed evidence that the termites gained entrance at the ground level. No characteristic shell similar to that in the DDT treatment was found. The untreated portion, or the distal third, of the post was attacked

more than the lower third at the time of the first observation, but at the second observation, the treated portion was as badly attacked as the untreated. In some instances, the treated portion was more seriously attacked than the untreated portion. While the treatment delayed termite attack, it did not prevent termites from constructing tunnels in the treated portion of the posts 19 days after the posts had been set in the ground. Judged by the nature of the attack on the treated portion of the posts, asphalt offered very little resistance to termite attack (fig. 4). This may be due to the fact that the

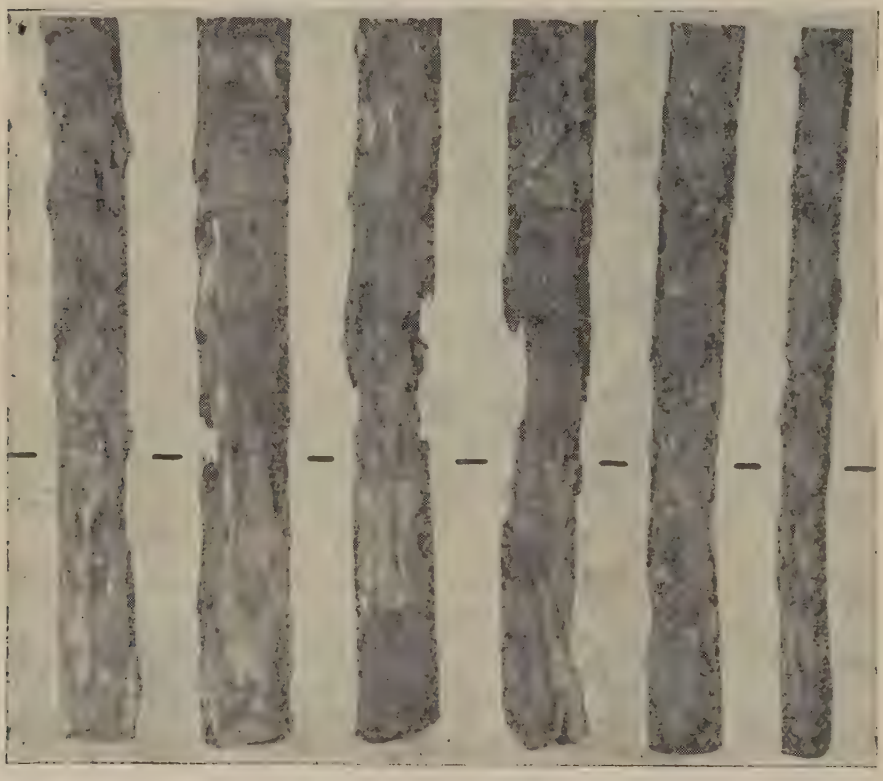


Fig. 4—Posts from the asphalt-treated lot at the conclusion of the tests. The broken line across the figure indicates the ground level.

asphalt served only as a coating and was not absorbed by the wood to any appreciable degree. In this connection, it is of interest to note that Hunt (1928) does not recommend the use of tar as wood preservative in the farm. He stated that tar does not penetrate wood readily. Sweetman and Bourne (1944) found that a twoply asphalt-laminated paper used as wrapping material was penetrated at times by *Reticulitermes flavipes* Koll. The asphalt layer, however, seemed resistant to the attack.

Control. The control lot was the worst attacked by the termites (fig. 5). The kerosene treatment had no effect on the termites; the kerosene-treated posts were the first to be attacked in the entire lot. Wilford (1944) found that of the 29 organic chemicals including kerosene that he tested for chemical impregnation of trees and poles for wood preservation, none was satisfactory.

Fig. 5.—Posts from the control lot at the conclusion of the tests. The broken line across the figure indicates the ground level.

Fungicidal properties. Of all the chemicals used, only pentachlorophenol exhibited some fungicidal effect on the treated posts. This effect, however, persisted for only about four months, after which the posts were attacked by fungi similar to those which attacked the posts in the other lots, including the control, about one month after treatment. In the posts treated with asphalt, the asphalt coating prevented the growth of fungi until about ten months after treatment, when this coating peeled off and fungi began to grow on the wood above the ground level. By this time all the posts were attacked by saprophytic fungi, the most common of which were *Stereum* sp., *Polyporus* sp., *Geoglossum* sp., *Auricularia auriculajudae* (L.) Schroet., and *Schizophyllum commune* Fr.[3]

[3] Identified by Dr. F. T. Orillo of the Department of Plant Pathology.

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TABLE 1

Efficacy of four insecticides used as fence post preservatives against subterranean termites

LOT	TREATMENT	OBSERVATION [a]	POSTS REMAINING AT TIME OF OBSERVATION		POSTS DISINTEGRATED AT TIME OF OBSERVATION		UNDERGROUND							
							Sound		Damaged					
									Slight		Moderate		Serious	
			Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
I	DDT	First	20	100.0	0	0.0	18	90.0	2	10.0	0	0.0	0	0.0
		Second	18	90.0	2	10.0	11	55.0	3	15.0	3	15.0	3	15.0
II	BHC	First	20	100.0	0	0.0	10	50.0	9	45.0	1	5.0	0	0.0
		Second	17	85.0	3	15.0	4	20.0	8	40.0	3	15.0	5	25.0
III	PCP	First	20	100.0	0	0.0	14	70.0	6	30.0	0	0.0	0	0.0
		Second	20	100.0	0	0.0	7	35.0	8	40.0	4	20.0	1	5.0
IV	Asphalt	First	20	100.0	0	0.0	9	45.0	11	55.0	0	0.0	0	0.0
		Second	15	75.0	5	25.0	1	5.0	2	10.0	7	35.0	10	50.0
V	Control	First	20	100.0	0	0.0	6	30.0	10	50.0	4	20.0	0	0.0
		Second	14	70.0	6	30.0	0	0.0	1	5.0	6	30.0	13	65.0

[a] The first observation was made on February 10, 1953, one year after the start of the test; the second on February 12, 1954, one year after the first.

TABLE 1 (continued)

LOT	TREATMENT	OBSERVATION [a]	GROUND LEVEL							
			Sound		Damaged					
					Slight		Moderate		Serious	
			Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
I	DDT	First	13	65.0	7	35.0	0	0.0	0	0.0
		Second	5	25.0	8	40.0	4	20.0	3	15.0
II	BHC	First	3	15.0	15	75.0	0	0.0	2	10.0
		Second	1	5.0	2	10.0	11	55.0	6	30.0
III	PCP	First	7	35.0	13	65.0	0	0.0	0	0.0
		Second	3	15.0	4	20.0	13	65.0	0	0.0
IV	Asphalt	First	3	15.0	14	70.0	0	0.0	3	15.0
		Second	0	0.0	2	10.0	5	25.0	13	65.0
V	Control	First	1	5.0	13	65.0	2	10.0	4	20.0
		Second	0	0.0	0	0.0	4	20.0	16	80.0

TABLE 1 (continued)

LOT	TREATMENT	OBSERVATION [a]	ABOVEGROUND							
			Sound		Damaged					
					Slight		Moderate		Serious	
			Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
I	DDT	First	13	65.0	6	30.0	1	5.0	0	0.0
		Second	0	0.0	5	25.0	9	45.0	6	30.0
II	BHC	First	1	5.0	17	85.0	2	10.0	0	0.0
		Second	0	0.0	0	0.0	10	50.0	10	50.0
III	PCP	First	1	5.0	19	95.0	0	0.0	0	0.0
		Second	0	0.0	2	10.0	13	65.0	5	25.0
IV	Asphalt	First	2	10.0	15	75.0	3	15.0	0	0.0
		Second	0	0.0	1	5.0	8	40.0	11	55.0
V	Control	First	0	0.0	16	80.0	4	20.0	0	0.0
		Second	0	0.0	0	0.0	7	35.0	13	65.0

A FURTHER STUDY ON TIMING THE APPLICATION OF FERTILIZER TO THREE VARIETIES OF RICE [1]

J. R. Velasco and M. R. Vega

Apportioning the nitrogenous fertilizer into three applications is better than applying it at one time. On grain yield of Elon-elon, potassium and phosphorus in combination with nitrogen did not have a significant effect. On Inintiw and Thailand rice, the second amount of fertilizer gave better results when applied at 30 days of age of the plants than at 45, 60, or 75 days. The largest grain yield of Inintiw was obtained with three fertilizer applications.

Certain contracting observations on the effectiveness of ammonium sulfate in different soil media emphasize the importance of the judicious use of nitrogenous fertilizers. The original fertility of the soil is an important consideration.

Velasco, Narit, and Fernandez [2] reported that rice plants need ammonium sulfate at the seedling stage, the mid-vegetative stage, and the late vegetative or early reproductive stage. This paper is a report of work done to confirm previous observations and to find a better criterion for timing the application of the fertilizer.

MATERIALS AND METHODS

The three varieties of rice planted were Elon-elon, Inintiw, and Thailand. Ammonium sulfate, potassium sulfate, and superphosphate were the fertilizers used. The method of rice culture was essentially similar to that followed by Velasco, Narit, and Fernandez.

EXPERIMENTAL RESULTS AND DISCUSSION

Experiment with Elon-elon. The experiment was designed to bring out (1) the difference between applying a given amount of fertilizer at one time and apportioning it in three applications; (2) the beneficial effects, if any, of phosphorus and potassium applied in conjunction with nitrogen; and (3) the difference between chronological timing and physiological timing of fertilizer application.

Six cultures with six replications each were planted to Elon-elon rice variety on July 29, 1953. The treatments given to the cultures are shown in table A.

The height of the plants and number of tillers were taken 30, 44, 58, 89, 103, 119, and 134 days after planting. The greatest increase in height was obtained during the first 44 days of life of the plants (table 1). Subsequently, the increases in height gradually declined. The tillers were most numerous at 58 days of age of the plants and then decreased towards maturity (table 2).

[1] Central Experiment Station Contribution No. 1782.

[2] J. R. Velasco, B. A. Narit, and D. B. Fernandez, *Philippine Agriculturist* **36**, 454 (1953).

TABLE A

Application of fertilizer to Elon-elon rice

CULTURE NUMBER	FIRST APPLICATION		SECOND APPLICATION		THIRD APPLICATION	
	Age of plants	Rate and kind of fertilizer	Age of plants	Rate and kind of fertilizer	Age of plants	Rate and kind of fertilizer
	days		*days*		*days*	
I		Without fertilizer		Without fertilizer		Without fertilizer
II	25	400 kg./ha. $(NH_4)_2SO_4$[a]				
III [b]	25	200 kg./ha. $(NH_4)_2SO_4$	66	100 kg./ha. $(NH_4)_2SO_4$	98	100 kg./ha. $(NH_4)_2SO_4$
IV	25	200 kg./ha. $(NH_4)_2SO_4$	60	100 kg./ha. $(NH_4)_2SO_4$	101	100 kg./ha. $(NH_4)_2SO_4$
V	25	200 kg./ha. $(NH_4)_2SO_4$ 200 kg./ha. K_2SO_4 200 kg./ha. superphosphate	60	100 kg./ha. $(NH_4)_2SO_4$	101	100 kg./ha. $(NH_4)_2SO_4$
VI [b]	25	200 kg./ha. $(NH_4)_2SO_4$ 200 kg./ha. K_2SO_4 200 kg./ha. superphosphate	60	100 kg./ha. $(NH_4)_2SO_4$	98	100 kg./ha. $(NH_4)_2SO_4$

[a] At the computed rate of 400 kg./ha., each pot received 2.47 grams of ammonium sulfate.
[b] The time of application was determined by leaf analysis for nitrogen

The plants were harvested on January 27, 1954, or 182 days after the seeds had been soaked. It took 130 days for the first inflorescence head to emerge and 52 days for the grains to reach harvesting age.

The highest grain yield was obtained from culture V (tables 3 and 3a), which was given nitrogen, phosphorus, and potassium at 25 days of age and nitrogen at 60 and 101 days of age. The differences between culture V on one hand and culture IV or culture III on the other were not significant. It may be concluded that the application of phosphorus and potassium in conjunction with nitrogen was not very beneficial to grain yield. The difference between culture V and culture VI, which equally received potassium and phosphorus and differed only in the time the nitrogen was applied, was greater than the difference between culture V and culture IV or III. One is led to the conclusion that a difference of a few days in the application of nitrogenous fertilizer can upset whatever good effect phosphorus and potassium can give.

The significant differences between cultures II and III and between cultures II and IV are a strong argument for apportioning the nitrogenous fertilizer into three applications.

On the other hand, the insignificant difference between cultures III and IV and the barely significant difference between cultures V and VI leave open the question of using leaf analysis as a guide in the application of nitrogen. In this experiment, cultures I, III, and VI were periodically analyzed for total nitrogen. As soon as the total nitrogen in the index leaves [3] of cultures III and VI approached that of culture I, the former were given a dose of ammonium sulfate. The comparable cultures, cultures IV and V, which were given the nitrogenous fertilizers at predetermined dates produced higher grain yields.

Culture V, the highest yielding culture in this experiment, yielded an average of 28 grams to a pot or 14 grams to a hill. At a distance of 25 centimeters each way between hills, the computed yield to a hectare was 2240 kilos. At 44 kilos to each cavan of palay, this yield is barely 51 cavans—a rather low yield for lowland rice.

Some factors were not considered in this experiment. For some time now, rice cultures in the kind of soil used in this experiment have been observed to turn yellow at 60 to 100 days of age, especially after a succession of bright, sunny days. The plants recover with the application of ammonium sulfate, but the condition recurs barely a month after. A study on the beneficial effect of micronutrient spray on this kind of yellowing is in progress.

Experiment with Inintiw. The objects of the experiment were to find out (1) whether one, two, or three fertilizer applications would give the best grain yield and (2) the best time to apply the fertilizer.

[3] J. R. Velasco and R. P. Novero, *Philippine Agriculturist*, 35, 223 (1951).

Seven cultures in quadruplicate were prepared and planted to Inintiw variety on June 1, 1953. The cultures were fertilized with 1 gram of ammonium sulfate (approximately 160 kg./ha.) at different ages (table B).

TABLE B

Application of fertilizer to Inintiw rice

CULTURE NUMBER	AGE OF PLANTS IN DAYS AT		
	First application	Second application	Third application
I	No fertilizer	No fertilizer	No fertilizer
II[a]	19	—	—
III	19	30	—
IV	19	45	—
V	19	45	75
VI	19	60	—
VII	19	75	—

[a] One gram of ammonium sulfate was applied to each pot in each application.

Height of plants and number of tillers were taken at 45, 60, and 91 days of age (tables 4 and 5).

On October 23, 1953, or 144 days after planting, the grains were harvested. Occasional dissections of the growing point revealed that differentiation of the flower bud to emergence of the inflorescence took 16 days. The earliest flower emergence was at 95 days of age, and the grains were harvested 49 days later.

The highest grain yield was obtained from culture V which received 1 gram of ammonium sulfate at 19, 45, and 75 days of age (tables 6 and 6a). The significant difference between cultures V and IV represents the yield due to the third application of the fertilizer. The insignificant difference between cultures II and IV is due to the fertilizer applied at 45 days of age. The second portion of fertilizer applied at 30 days of age (culture III) had a markedly beneficial effect than when applied at 45, 60, or 75 days of age (cultures IV, VI, and VII). It seems that the successive applications of nitrogenous fertilizers, in order to be effective, must sustain an even, continuous growth; when they are so far apart that growth slackens during the intervals, the good effects of some of the applications are lost.

Fertilization at 30 days resulted in an increased number of panicles, whereas application at 75 days increased the weight of a panicle. Inintiw, like Elon-elon, appears to have three distinct receptive stages to nitrogen fertilization. The possibility of the second and

third receptive stages being identical, as suggested by Velasco, Narit, and Fernandez,[4] was discounted by these data.

Experiment with Thailand rice. The fertilized pots used in the Elon-elon experiment were reshuffled to cancel out differences among them caused by the fertilizer treatment. The unfertilized pots were again used as control. On February 15, 1954, they were planted to the Thailand variety of rice and when they were 15 days old, the fertilized lots were given 200 kg./ha. ammonium sulfate, 200 kg./ha. potassium sufate, 200 kg./ha. superphosphate, 200 kg./ha. magnesium sulfate, and 10 ml. to a pot of a micronutrient mixture. Then ammonium sulfate at the rate of 100 kg./ha. was added to culture II at 25 days of age, to culture III at 40 days, to culture IV at 55 days, to culture V at 70 days, and to culture VI at 80 days. The original plan was to use Elon-elon and to give all the treated pots a third application of ammonium sulfate at 100 days of age of the plants. At this age the flower buds were expected to be differentiating or about to differentiate. The variety was changed to Thailand, however, because the period of the year was not suited to Elon-elon, and rather unwisely, no allowance was made for the much shorter vegetative period of Thailand rice.

One panicle emerged at 76 days of age and the other panicles followed a few days later. The plan of making a third application at 100 days was therefore abandoned. The experiment as performed supplied information on the effectiveness of the second application at different ages.

Height of plants and number of tillers were taken at 31 and 61 days of age (tables 7 and 8).

The panicles were ready for harvesting 135 days after planting among the fertilized plants and 149 days after planting among the unfertilized plants. The difference of about half a month between the maturity periods of the fertilized plants and the unfertilized lots is unusual. Also noteworthy is the fact that fertilization hastened the maturity of this variety. Usually fertilization with nitrogen somewhat delays the maturity of most varieties of rice.

The highest yield of grains was obtained from culture II which was fertilized at 15 days and 25 days of age (tables 9 and 9a). As the interval between the two fertilizer applications was increased, the grain yield gradually decreased. This observation, together with that on Inintiw, emphasizes the need for adequate amounts of nutrients, especially of nitrogen, in the early stages of development of the plant. This need was made even more acute by the unusually poor soil that was used in this experiment. If the soil had been from an ordinary rice field which contained an appreciable amount of original fer ility, the results might have been different. In one of our unsuccessful experiments on Dr. F. Ordoveza's farm at Bay, Laguna, application of ammonium sulfate a few days after transplanting was found to

[4] Velasco, Narit, and Fernandez, *op. cit.*

produce tall plants. It also aggravated the tendency of rice plants on this farm to produce weak, spindling stalks in general. When a typhoon occurred in October at about the time the plants were heading, the fertilized plants lodged heavily and most of the grains subsequently produced were unfilled.

These contrasting observations emphasize the importance of the judicious use of nitrogenous fertilizers. In soils poor in nitrogen, nitrogenous fertilizers may be a boon to the farmer; in fairly rich soils, they may detract from, rather than add, to the farm income.

The fertilized lots were taller than the unfertilized lots. Fertilization at about the time of flower bud differentiation was particularly effective. The lots that were fertilized at this stage were about one and one-third times as tall as the unfertilized lot. This effect of the fertilizer is not desirable because tall plants are more prone to lodge. It would be a decided contribution if plant breeders could develop a variety which responds to fertilizer by an increased production of tillers without the concomitant increase in height.

Plants that were fertilized at the stage of flower bud differentiation changed their grain-to-straw ratios in favor of the grain. This implies that more economical plants were produced. It is also striking that varieties differed in their grain-to-straw ratios. Apparently, the shorter the growing period, the more grains are produced in relation to the straw. This is one advantage that short-season varieties have over the late varieties, in addition to the shorter period in which the field is occupied by the crop.

TABLE 1

Height of Elon-elon rice plants fertilized at different ages

CULTURE	AGE IN DAYS	HEIGHT IN CENTIMETERS												AVERAGE
		Pot 1		Pot 2		Pot 3		Pot 4		Pot 5		Pot 6		
		a	b	a	b	a	b	a	b	a	b	a	b	
I	30	30	30	26	30	26	30	28	34	27	34	32	33	30.0
	44	44	42	53	51	49	52	45	53	46	58	50	50	49.4
	58	58	55	66	64	67	66	59	70	60	56	59	56	61.3
	89	67	74	70	69	68	68	62	83	62	68	66	68	68.7
	103	74	73	76	83	80	84	69	90	67	78	71	73	76.5
	119	82	84	88	90	88	91	70	96	70	85	77	77	83.2
	134	88	93	97	101	95	102	81	102	86	90	82	85	91.8
II	30	29	31	35	25	31	30	29	30	30	28	31	32	30.1
	44	57	61	70	52	62	53	56	57	58	56	64	65	59.2
	58	74	72	76	81	80	82	80	76	79	78	72	75	77.1
	89	72	71	84	86	87	97	85	85	82	81	77	81	82.3
	103	78	76	90	92	101	97	92	92	98	88	77	89	89.2
	119	82	84	97	104	101	107	102	95	105	94	82	98	95.9
	134	98	88	107	104	115	120	121	109	115	100	96	104	106.4
III	30	33	37	27	28	30	28	34	30	30	28	28	29	30.2
	44	41	55	57	58	61	59	60	60	53	56	58	63	56.7
	58	—	69	78	81	76	75	69	70	72	66	66	69	71.9
	89	81	94	92	92	97	94	93	93	88	93	73	83	89.4
	103	85	96	95	100	103	94	96	96	90	102	83	76	93.0
	119	105	113	118	117	120	121	118	117	110	115	108	113	114.6
	134	102	115	121	121	129	129	129	130	124	121	117	118	121.3

TABLE 1 (continued)

CULTURE	AGE IN DAYS	HEIGHT IN CENTIMETERS												AVERAGE
		Pot 1		Pot 2		Pot 3		Pot 4		Pot 5		Pot 6		
		a	b	a	b	a	b	a	b	a	b	a	b	
IV	30	31	32	30	26	27	30	33	32	30	25	33	31	30.0
	44	65	67	60	59	58	59	62	61	61	60	57	62	60.9
	58	72	70	72	72	70	66	74	69	65	67	61	68	68.8
	89	87	86	86	82	83	80	84	85	82	78	83	79	82.9
	103	85	89	87	84	87	80	84	87	85	83	84	80	84.6
	119	105	109	113	105	104	102	120	108	114	95	107	103	107.1
	134	121	122	122	119	118	108	128	122	141	105	119	114	119.9
V	30	23	28	24	30	29	32	33	31	34	30	34	36	30.7
	44	57	55	52	56	53	60	61	61	61	51	64	66	58.5
	58	64	65	61	64	74	68	68	63	68	62	73	71	66.7
	89	78	80	79	76	94	82	80	81	85	80	95	91	83.4
	103	78	80	80	84	95	83	86	83	83	82	93	91	84.8
	119	102	103	103	106	108	101	110	107	106	101	118	114	106.6
	134	110	116	111	120	123	114	121	119	112	104	140	125	117.9
VI	30	27	30	32	30	31	30	27	36	31	26	27	34	30.1
	44	57	61	63	61	61	55	54	65	61	58	56	65	59.7
	58	63	67	65	64	69	61	67	68	67	66	66	69	66.0
	89	71	85	79	87	84	80	87	87	86	81	80	83	82.5
	103	82	88	81	88	88	81	86	90	92	88	97	90	87.6
	119	103	104	106	111	108	100	111	111	112	108	113	115	108.5
	134	102	114	114	118	116	106	116	124	120	116	117	124	115.6

TABLE 2

Number of tillers of Elon-elon rice plants fertilized at different ages

CULTURE	AGE IN DAYS	NUMBER OF TILLERS												AVERAGE
		Pot 1		Pot 2		Pot 3		Pot 4		Pot 5		Pot 6		
		a	b	a	b	a	b	a	b	a	b	a	b	
I	44	1	1	2	1	2	3	1	2	2	3	1	2	1.7
	58	2	2	4	3	5	8	3	2	3	3	3	4	3.5
	89	2	2	3	3	5	8	3	2	3	4	3	4	3.5
	103	2	4	3	2	3	5	2	3	3	3	3	4	3.1
	119	2	3	2	1	2	4	2	2	2	3	2	2	2.3
	134	2	2	2	1	2	3	2	2	2	3	2	3	2.2
II	44	4	8	10	4	7	5	7	6	7	4	10	8	6.7
	58	13	16	24	13	22	13	19	17	20	11	19	17	17.0
	89	11	16	20	11	19	10	17	13	17	10	14	15	14.4
	103	10	12	15	8	14	8	12	10	13	6	12	10	10.8
	119	7	10	11	5	10	3	8	6	7	4	9	16	17.2
	134	5	9	9	4	8	3	5	4	7	4	8	6	6.0
III	44	3	11	4	4	6	5	5	5	5	8	7	7	5.8
	58	—	18	14	12	14	11	11	13	12	20	14	14	13.9
	89	11	17	11	11	12	10	11	12	9	11	10	13	11.5
	103	12	15	13	9	10	9	11	10	10	11	9	13	11.00
	119	8	13	8	7	6	6	5	7	6	6	6	9	7.2
	134	4	12	5	7	5	5	5	7	5	6	5	7	6.1

TABLE 2 (continued)

CULTURE	AGE IN DAYS	NUMBER OF TILLERS												AVERAGE
		Pot 1		Pot 2		Pot 3		Pot 4		Pot 5		Pot 6		
		a	b	a	b	a	b	a	b	a	b	a	b	
IV	44	9	11	10	4	8	9	8	7	7	5	7	7	7.7
	58	23	21	20	12	16	15	16	15	12	10	14	15	15.7
	89	17	16	16	12	14	14	14	14	11	10	14	15	13.9
	103	14	13	13	10	12	11	12	9	10	9	12	11	11.3
	119	12	11	11	7	6	7	7	7	6	7	8	7	8.0
	134	10	9	9	6	7	7	6	6	4	5	8	7	7.0
V	44	6	6	5	5	6	8	9	11	13	4	10	12	7.9
	58	9	11	9	13	9	12	14	17	21	9	19	24	13.9
	89	9	12	10	12	9	12	13	16	17	10	14	17	12.6
	103	9	9	10	10	7	10	11	12	16	9	12	16	10.9
	119	6	8	7	9	5	8	7	10	11	5	9	11	8.0
	134	6	8	7	8	5	7	6	10	9	5	9	10	7.5
VI	44	7	9	5	8	8	8	4	8	6	6	4	7	6.7
	58	12	16	7	12	15	11	7	15	13	9	10	11	11.5
	89	10	15	9	11	13	12	8	13	11	10	9	11	11.0
	103	10	12	8	11	13	10	9	12	12	7	9	10	10.2
	119	7	9	5	8	9	7	5	9	6	5	6	8	7.0
	134	6	9	5	7	7	7	5	9	6	5	5	7	6.5

TABLE 3

Yield of grain of Elon-elon rice plants

CULTURE	WEIGHT OF GRAINS	NO. OF PANICLES	WEIGHT OF A PANICLE	AIR-DRY WEIGHT OF STRAW	GRAIN TO STRAW RATIO
	grams		*grams*	*grams*	
1	5.7	5	1.14	15.5	
2	4.7	4	1.17	13.9	
3	5.8	4	1.45	13.7	
I 4	9.3	5	1.86	13.7	
5	5.4	3	1.80	16.4	
6	4.8	4	1.20	14.4	
Average	5.95	4.2	1.44	14.60	1:2.46
1	19.8	14	1.41	64.6	
2	16.2	9	1.80	62.7	
3	19.0	11	1.73	64.2	
II 4	15.3	9	1.70	106.6	
5	22.3	14	1.59	77.9	
6	14.4	13	1.11	50.0	
Average	17.80	11.7	1.56	71.00	1:4.00
1	26.6	12	2.22	70.4	
2	23.4	11	2.12	67.2	
3	27.8	11	2.53	85.7	
III 4	20.4	9	2.27	80.3	
5	27.7	11	2.52	85.5	
6	23.6	16	1.47	78.9	
Average	24.92	11.7	2.19	78.00	1:3.13
1	21.3	15	1.42	76.0	
2	26.6	10	2.66	62.1	
3	24.9	10	2.49	87.6	
IV 4	27.8	14	1.98	66.7	
5	27.4	14	1.96	115.5	
6	30.5	18	1.69	106.5	
Average	26.42	13.5	2.03	85.73	1:3.24
1	43.2	13	3.32	126.5	
2	26.4	12	2.20	94.3	
3	31.0	14	2.21	94.3	
V 4	19.0	13	1.36	84.1	
5	24.1	12	2.01	64.8	
6	24.3	14	1.73	66.2	
Average	28.00	13.00	2.14	88.40	1:3.16
1	22.9	13	1.76	62.3	
2	21.5	12	1.79	91.6	
3	25.1	14	1.79	107.2	
VI 4	27.5	14	1.96	110.5	
5	22.0	12	1.83	65.9	
6	23.6	14	1.68	69.9	
Average	23.77	13.2	1.80	84.57	1:3.56

TABLE 3a

Yield of grain in grams of Elon-elon fertilizer experiment

CULTURE NUMBER	REPLICATION						AVERAGE
	1	2	3	4	5	6	
I	5.7	4.7	5.8	9.3	5.4	4.8	5.95
II	19.8	16.2	19.0	15.3	22.3	14.4	17.83
III	2/	23.4	27.8	20.4	27.7	23.6	24.92
IV	21.3	26.6	24.9	29.8	27.4	30.5	26.75
V	43.2	26.4	31.0	19.0	24.1	24.3	28.00
VI	22.9	21.5	25.1	27.5	22.0	23.6	23.77

Analysis of variance of grain yield

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	F-VALUE		
				Computed	Tabular	
					1%	5%
Total	35	2586.11				
Treatment	5	2048.05	409.61	22.83	3.70	2.53
Error	30	538.06	17.94			

L.S.M.D. = 4.9

TABLE 4

Height of Inintiw rice plants fertilized at different ages

CULTURE	AGE IN DAYS	HEIGHT IN CENTIMETERS								AVERAGE
		Repl. 1		Repl. 2		Repl. 3		Repl. 4		
		a	b	a	b	a	b	a	b	
I	45	38	38	43	37	42	41	46	50	41.9
	60	49	48	51	49	52	52	46	53	50.0
	91	65	72	73	64	72	70	60	69	68.1
II	45	55	54	53	62	64	58	59	63	58.5
	60	67	59	54	60	68	59	61	57	60.6
	91	83	77	75	71	81	85	74	79	78.1
III	45	52	51	56	62	61	60	60	63	58.1
	60	69	62	73	80	80	84	74	75	74.6
	91	86	86	91	100	97	93	92	86	91.4
IV	45	58	58	58	56	63	62	53	64	59.0
	60	73	78	71	74	71	76	78	78	74.9
	91	90	88	94	94	88	88	89	99	91.3
V	45	63	60	58	58	55	56	54	59	57.9
	60	79	79	68	68	79	71	71	75	73.8
	91	99	92	94	96	99	97	95	90	95.3
VI	45	63	60	58	58	55	56	54	59	57.9
	60	61	61	61	60	66	62	59	65	61.9
	91	95	96	96	93	94	93	92	102	95.1
VII	45	64	60	53	44	63	63	56	55	57.3
	60	50	61	61	60	54	63	64	64	59.6
	91	80	83	85	83	88	92	87	90	86.0

TABLE 5

Number of tillers of Inintiw rice plants fertilized at different ages

CULTURE	AGE IN DAYS	NUMBER OF TILLERS								AVERAGE
		Repl. 1		Repl. 2		Repl. 3		Repl. 4		
		a	b	a	b	a	b	a	b	
I	45	2	1	3	2	3	1	4	3	2.4
	60	3	2	3	2	3	2	5	3	2.9
	91	3	2	3	2	3	2	5	3	2.9
II	45	4	8	8	15	8	8	6	6	7.9
	60	6	10	10	15	11	8	7	5	9.0
	91	6	8	9	10	8	7	7	4	7.4
III	45	8	6	5	4	8	6	8	10	6.9
	60	13	9	11	12	12	13	12	14	12.0
	91	11	7	8	9	9	10	9	10	9.1
IV	45	9	8	8	6	8	9	6	11	8.1
	60	16	16	17	12	11	16	16	19	15.4
	91	11	8	10	8	9	10	6	15	9.6
V	45	11	10	7	9	5	6	8	8	8.0
	60	18	11	11	18	10	11	14	16	13.6
	91	15	10	8	11	8	8	9	10	9.9
VI	45	13	11	4	2	5	8	8	4	6.9
	60	14	12	8	3	7	8	9	5	8.3
	91	11	9	7	5	6	7	8	7	7.5
VII	45	7	8	8	9	8	8	5	7	7.5
	60	8	10	10	10	9	9	7	8	8.9
	91	7	9	9	8	8	7	5	6	7.4

TABLE 6

Yield of grain of Inintiw rice plants

CULTURE NUMBER	REPLICATION	WEIGHT OF GRAINS IN GRAMS	NO. OF PANICLES	WEIGHT OF STRAW IN GRAMS	RATIO
I	1	4.2	5	6.3	
	2	5.3	5	7.3	
	3	6.3	5	9.4	
	4	5.8	6	7.7	
	Average	5.40	5.3	7.7	1:1.43
II	1	11.3	9	19	
	2	16.3	14	30.9	
	3	9.6	12	21.0	
	4	16.4	11	23.8	
	Average	13.40	11.5	23.7	1:1.77
III	1	19.9	15	44.6	
	2	19.8	13	57.7	
	3	24.5	17	50.0	
	4	16.2	14	38.3	
	Average	20.10	14.8	47.6	1:2.36
IV	1	17.3	12	38.6	
	2	11.2	8	41.4	
	3	20.2	16	43.6	
	4	17.0	17	49.6	
	Average	16.43	13.3	43.3	1:2.63
V	1	13.7	12	30.4	
	2	30.0	20	50.4	
	3	20.6	9	43.5	
	4	26.4	19	64.3	
	Average	22.68	15.0	47.2	1:2.08
VI	1	12.7	9	31.3	
	2	17.4	12	35.0	
	3	10.1	8	22.9	
	4	14.9	18	37.8	
	Average	13.77	11.7	31.7	1:2.30
VII	1	16.9	11	22.0	
	2	14.2	8	22.7	
	3	14.9	12	27.2	
	4	12.8	12	24.3	
	Average	14.70	10.7	24.1	1:1.63

TABLE 6a

Yield of grain in grams of Inintiw fertilizer experiment

CULTURE NUMBER	REPLICATION				AVERAGE
	1	2	3	4	
I	4.2	5.3	6.3	5.8	5.40
II	11.3	16.3	9.6	16.4	13.40
III	19.9	19.8	24.5	16.2	20.10
IV	17.3	11.2	20.2	17.0	16.43
V	13.7	30.0	20.6	26.4	22.68
VI	12.7	17.4	10.1	14.9	13.78
VII	16.9	14.2	14.9	12.8	14.70

Analysis of variance of grain yield

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	F-VALUE		
				Computed	Tabular	
					1%	5%
Total	27	1038.01				
Treatment	6	731.78	121.96	8.36	3.81	2.57
Error	21	306.23	14.58			

L.S.M.D. = 5.60

TABLE 7

Height of Thailand rice plants fertilized at different ages

CULTURE NUMBER	AGE IN DAYS	HEIGHT IN CENTIMETERS												AVERAGE
		Pot 1		Pot 2		Pot 3		Pot 4		Pot 5		Pot 6		
I	31	30	32	33	37	33	34	38	38	38	37	34	34	34.83
	61	60	63	60	55	50	56	64	65	60	56	53	51	57.75
II	31	45	47	49	46	48	37	39	42	45	50	40	44	44.33
	61	77	78	81	85	79	73	81	80	74	84	69	81	78.50
III	31	46	41	52	49	51	47	44	50	46	40	41	45	46.00
	61	82	85	83	90	83	91	85	84	79	75	77	77	82.58
IV	31	48	44	53	50	43	45	43	44	40	44	46	44	45.33
	61	77	70	80	81	82	82	77	73	75	78	75	66	76.33
V	31	49	48	50	50	50	51	46	47	49	46	48	50	48.66
	61	83	69	73	80	86	83	70	72	78	63	74	80	75.92
VI	31	47	51	52	56	48	49	47	44	47	47	45	47	48.33
	61	79	74	78	75	86	78	81	78	71	75	71	69	76.25

TABLE 8

Number of tillers of Thailand rice plants fertilized at different ages

CULTURE	AGE IN DAYS	NUMBER OF TILLERS												AVERAGE
		Pot 1		Pot 2		Pot 3		Pot 4		Pot 5		Pot 6		
I	31	1	1	1	2	1	1	2	2	2	2	1	1	1.42
	61	4	5	3	5	4	3	6	9	5	9	5	4	5.17
II	31	6	8	7	4	7	3	3	5	5	7	4	4	5.25
	61	13	13	20	13	24	13	10	21	14	17	24	21	16.91
III	31	6	3	8	7	5	5	6	6	5	4	4	6	5.42
	61	21	13	19	14	26	21	13	18	14	12	14	16	16.75
IV	31	7	5	7	6	4	7	5	7	3	4	8	6	5.75
	61	14	11	13	10	12	13	14	17	12	16	22	17	14.25
V	31	6	4	8	7	4	5	6	5	5	4	6	7	5.58
	61	12	16	15	13	14	13	13	11	11	10	12	11	12.58
VI	31	4	6	5	6	4	4	5	6	5	5	7	7	5.33
	61	7	11	11	11	13	18	12	17	13	10	11	11	12.08

TABLE 9

Yield of grain of Thailand rice plants

CULTURE NUMBER	WEIGHT OF GRAINS	NO. OF PANICLES	WEIGHT OF A PANICLE	AIR-DRY WEIGHT OF STRAW	GRAIN TO STRAW RATIO
	grams		*grams*	*grams*	
1	9.2	8	1.15	12.5	
2	12.4	12	1.03	18.5	
3	9.8	8	1.22	13.0	
I 4	9.8	8	1.22	14.8	
5	9.4	10	0.94	20.5	
6	13.4	10	1.34	15.2	
Average	10.67			15.75	1:1.48
1	26.4	31	0.85	64.8	
2	28.7	22	1.30	36.3	
3	32.0	25	1.28	53.5	
II 4	32.2	30	1.73	45.8	
5	28.7	20	1.43	40.5	
6	20.7	21	0.98	28.0	
Average	28.12			44.82	1:1.59
1	30.2	25	1.20	46.0	
2	23.4	23	1.01	53.6	
3	21.7	17	1.27	46.4	
III 4	26.6	25	1.06	43.5	
5	22.2	21	1.57	47.3	
6	25.7	23	1.11	38.0	
Average	24.97			45.8	1:1.83
1	20.4	26	0.78	40.0	
2	31.8	22	1.44	48.8	
3	24.4	16	1.52	37.0	
IV 4	32.3	18	1.79	57.7	
5	8.9	11	0.80	47.8	
6	24.9	18	1.38	44.6	
Average	23.78	18		45.98	1:1.93
1	27.6	19	1.45	40.0	
2	31.4	19	1.92	34.5	
3	20.9	17	1.22	31.7	
V 4	30.9	20	1.54	45.0	
5	29.5	21	1.40	40.7	
6	18.0	15	1.2	38.9	
Average	26.38			38.46	1:1.46
1	17.1	18	0.95	29.1	
2	23.0	15	1.53	25.5	
3	30.4	22	1.38	50.2	
VI 4	16.1	16	1.006	48.0	
5	19.8	17	1.16	41.6	
6	12.8	11	1.16	28.7	
Average	19.87			37.18	1:1.87

TABLE 9a

Analysis of variance of grain yield

CULTURE NUMBER	WEIGHT IN GRAMS						AVERAGE
	1	2	3	4	5	6	
I	9.2	12.4	9.8	9.8	9.4	13.4	10.67
II	26.4	28.7	32.0	32.2	28.7	20.7	28.12
III	30.2	23.4	21.7	26.6	22.2	25.7	24.97
IV	20.4	31.8	24.4	32.3	8.9	24.9	23.78
V	27.6	31.4	20.9	30.9	29.5	18.0	26.38
VI	17.1	23.0	30.4	16.1	19.8	12.8	19.87

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	F-VALUE		
				Computed	Tabular	
					1%	5%
Total	35	2084.99				
Treatment	5	1206.45	241.29	82.40	3.70	2.53
Error	30	878.54	29.28			

L.S.M.D. = 6.36

FARM INVESTMENT AND INCOME OF RICE FARMERS IN THE MAAHAS-MAITIM AREA, LAGUNA, 1952-1953 [1]

ORLANDO J. SACAY

Of the 99 farmers surveyed, 84 were tenants, 9 were part-owners, and 6 were owners. The average capital investment in a farm was ₱10,920; of this, 83.6 per cent was owned by the landlord and 91.8 per cent was invested in land. On the tenant-operated farms, the operator owned only 7.6 per cent of the average capital investment. The average size of a farm was 2.01 hectares, 89.6 per cent of which was planted to lowland rice.

The average farm receipts were ₱1730, of which 86.1 per cent came from rice. The tenant-operated farms had the biggest farm receipts; the owner-operated farms, the smallest. The farm expenses averaged ₱1263 for each farm. The largest items of expense were land rent and the harvester's share of the crop. The average labor income was ₱364. The part-owners and owners had negative labor incomes. The labor earnings averaged ₱767 to a farm. The tenants had higher labor earnings than the part-owners and owners. A positive relationship existed between effective crop area and labor earnings. The average nonfarm income of the operator was ₱67; that of the family was ₱28. The amount available for family living averaged ₱956, of which 87.2 per cent was earned by the operator.

In planning any program for the economic improvement of the farmer, a knowlege of such factors as his investments, the size of his farm, his production, and his earnings is important. A farmer's investments will determine the amount of credit that he may obtain from banks requiring collateral. His production will have a bearing on the amount that credit institutions will be willing to loan him on the basis of productive capacity. The size of his earnings will indicate his economic level, which influences his standard of living.

An investigation was conducted from May to June, 1953, in the barrios of Maahas in Los Baños, Laguna, and Maitim in Bay, Laguna, to study (1) the amount of capital invested by rice farmers in that area, (2) the size of their farm business, and (3) their farm receipts, expenses, and income.

The survey method was employed. Data on farm business for the crop year 1952-1953 were secured from interviews with the farmers, their wives, and other members of the family and were recorded in schedules prepared in the Department of Agricultural Economics. All the rice farmers in the area were included in the study.

FINDINGS AND DISCUSSION

Description of the area surveyed. The Maahas-Maitim area is composed of two adjoining barrios, Maahas in Los Baños and Ma-

[1] Central Experiment Station Contribution No. 1783. Thesis presented for graduation, 1954, with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Agricultural Economics under the direction of Professor Lynn S. Robertson and Assistant Professor Nathaniel B. Tablante.

itim in Bay, both located in the north-central part of Laguna. The area is bounded on the north by Laguna de Bay, on the east by another barrio of the municipality of Bay, on the south by another barrio and the College of Agriculture Central Experiment Station, and on the west by another barrio of Los Baños. A highway and a railroad track pass through the area.

The dominant farm enterprise is rice production. A hectare of unirrigated lowland is valued at ₱3000 to ₱4000, and a hectare of irrigated lowland, at ₱6000 to ₱7000. Artificial irrigation is made possible by the use of pumps and natural springs. Some of the farms depend entirely upon rain water for irrigation of the fields.

Barrio Maahas had 27 rice farmers. Barrio Maitim, which is composed of four sitios, Tabon, Mainit, Kabaritan, and Maitim, had 72. There were 20 farmers in Tabon, 13 in Mainit, 10 in Kabaritan, and 29 in Maitim.

Age of farm operators. The ages of the farm operators ranged from 17 to 72 years, or an average of 35.5 years. Almost one-half of the farmers were 25 to 39 years old; only 17 per cent were below 25.

Length of farming experience. The operators had been engaged in farming from 1.5 to 60 years, or an average of 16.5 years. They had been operating the farms they were on for an average of 10.4 years.

Tenure. Of the 99 farmers surveyed, 84 were tenants, 9 were part-owners, and 6 were owners. The tenants owned the buildings, tools, work animals, and other livestock; the landlord owned the land and, on some farms, the work animals. The 50-50 sharing system was followed on the irrigated lowland farms. The landlord shared in the expenses for fertilizers and seeds. On the upland or on the unirrigated lowland farms, the sharing was 2/3-1/3. Under this system, the tenants shouldered all the expenses except the cost of seeds, which was shared equally. Besides the buildings, tools, work animals, and other livestock, the part-owners owned part of the land.

Capital investment. The average capital investment for all the farms was ₱10,290, of which 83.6 per cent was owned by the landlords; 91.8 per cent was invested in land (table 1). The average capital investment for the tenant-operated farms was ₱11,103, of which 7.6 per cent was owned by the operators. The landlords owned the land, which comprised 92.2 per cent of the total capital investment, and 5.5 per cent of the investment in work animals.

The capital investment in the farms operated by the part-owners was higher. The part owners owned 64.9 per cent of the total capital investment, or 61.4 per cent of the land investment.

The farms of the owner-operators had the lowest total average capital investment. Land investment comprised 82.6 per cent of the total investment. The next biggest items of capital investment were buildings and work animals.

Size of farm. Of the average farm area (table 2), 89.6 per cent was lowland. The size of the tenant-operated farms ranged from ½ to 5 hectares, or an average of 1.95 hectares; that of the partly owned farms, from 1⅓ to 5½ hectares, or an average of 3.04 hectares; and that of the owner-operated farms, from ½ to 2½ hectares, or an average of 1.27 hectares.

The tenants had a smaller total farm area but a greater effective area than the part-owners because 81.4 per cent of the lowland fields of the tenant-operated farms was artificially irrigated. Only 8.7 per cent of the lowland fields of the part-owners was artificially irrigated. Artificial irrigation made possible two crops of rice a year.

Crops grown. Rice was the principal crop grown by all the farmers. The average area planted to rice was 1.91 hectares, of which 1.80 hectares were planted to lowland rice (table 2). An average of 3.13 hectares of lowland rice was harvested during the year (table 3). The average yield of lowland rice was 176.9 cavans to a farm (table 4).

Upland rice made up only about one-half per cent of the average rice production for the entire year (table 4). The farms operated by part-owners had the lowest yield to a hectare. The farms run by tenants and by owners had almost the same yields to a hectare although the yield to a hectare a year was slightly higher on the tenant-operated farms.

There was no marked difference in yield to a hectare between the small and the big tenant-operated farms (table 5). It appears that the size of a farm did not greatly influence the rate of farm productivity.

Corn, coconut, cowpea, sitao, mungo, eggplant, tomato, upo, and patola were grown in limited quantities. Fruits were grown on a very limited scale.

Livestock raised. The carabao was the work animal used on the farms (table 6). Chickens, ducks, and swine were raised on the farms. A few horses and goats were found. The sources of income from livestock were carabaos, swine, chickens, and ducks (table 7).

Farm receipts. Rice, the principal source of income, constituted 90.4 per cent of the crops sold by the operator (table 8). When the landlord's share and the harvester's share were included as receipts, rice made up 86.1 per cent of the total farm receipts. On the tenant-operated farms, rice constituted a bigger part of the total farm receipts, 90.1 per cent. On the farms run by part-owners, it made up 36.3 per cent of the total farm receipts; on the owner-operated farms, 40.4 per cent. Next to rice in importance as a source of income was livestock. Other sources of income were eggplant, corn, coconut, sitao, mungo, and tomatoes.

The tenants had the biggest farm receipts, and the owners had the smallest (table 8). The total farm receipts of the tenants increased proportionally to the size of the farm (table 9).

The tenants, part-owners, and owners sold part of their rice shares (table 10). Among the tenants, a higher percentage of the total share of the rice crop was sold as the size of the farm increased.

Farm expenses. The tenants had the biggest farm expenses, and the owners, the least (table 8) because the tenants had bigger farms and must pay for the use of the land in the form of the landlord's share. The largest expense item, land rent, amounted to 57.3 per cent of the total farm expenses, or one-half of the net lowland production and one-third of the net upland production. Net production is what is left after the harvester's share has been deducted from the total rice produced. Among the tenants, land rent comprised 59.2 per cent of the farm expenses, and among the part-owners, 37.6 per cent.

Another big item of expense was the harvester's share, which made up 23.9 per cent of the total farm expenses. The harvester's share was one-fifth or one-sixth of the total harvest.

Also a large item of expense was the operator's cash expenses (table 11). The biggest cash expense item was building materials. The other items in the order of their importance were interest on farm loans, cash rent for work animals, hired man and animal labor, and fertilizer and irrigation fees. The interest on farm loans was high because of the high rates of interest in the credit transactions. The rent for work animals was also high. Minor items of cash expense were rope, repair of tools, branding fee, and taxes. The size of the farm was directly related to the cash expenses (table 12).

Other items of farm expenses were unpaid family labor and purchased tools, equipment, and livestock.

Labor income. The net farm income is obtained by deducting the total farm expenses from the total farm receipts. From the net farm income is deducted the interest on the operator's inventory, excluding assets on which interest has actually been paid, and the difference represents the labor income. The average labor income for all the farms was ₱364 (table 8). Among the tenants, the increase in labor income due to increase in size of the farm was very evident (table 9).

Labor earnings. The operator's labor earnings include the value of farm privileges, which consists of the value of the farm products used in the operator's household and the value of one year's use of the operator's house. On Philippine farms, especially rice farms, labor earnings are a better measure of success than labor income since a very large proportion of the farm products is used by the farmer's household, leaving very little or nothing for sale.

Among the crops consumed on each farm, rice constituted a very big proportion (table 13). The livestock and livestock products used on the farm consisted of swine, poultry, and poultry products. Their average value for all the farms was insignificant when compared with the value of the crops used by the operator's household (table 15). Other farm privileges consisted of fruits, vegetables, and use of the dwelling. The value of farm privileges was highest among the owners and lowest among the tenants.

In the tenant group, the amount of farm privileges increased with an increase in the size of the farm (table 14), probably because the farmers with bigger farms generally had bigger families. The farmers operating bigger farms sold a bigger proportion of the rice crop shared although they used more crops in the household than those with smaller farms (table 10). The consumption of products in the household did not increase at the same rate as the increase in production to a farm resulting from an increase in the size of the farm; hence, a larger proportion of the rice crop shared was sold by the operators.

The tenants had higher labor earnings than the part-owners or the owners (table 8).

The labor earnings increased with an increase in the size of the farm. Since the effective crop area represents the area actually cropped, or the area of crops actually planted and harvested, it can be more effectively used than total farm area in determining the influence of area on the labor earnings. As the effective crop area of a tenant farm increased, there was a corresponding increase in the labor earnings (table 16). The increase in effective crop area was responsible for 56.8 per cent of the increase in labor earnings. The size of the effective crop area of a farm, therefore, influences greatly the relative success of a farmer and, consequently, the standard of living of his family.

Nonfarm income of farm operators. The operator's nonfarm income (table 8) represented his income from jobs done off his farm, such as plowing, harrowing, planting, and doing other work for other farmers; harvesting, hauling, and buying and selling coconuts; fishing; and engaging in the calesa transportation business, carpentry, or commerce.

Tenants who had bigger labor earnings had smaller nonfarm incomes, whereas part-owners and owners who had smaller labor earnings had bigger nonfarm incomes. Among the tenants, those with smaller farms and correspondingly smaller labor earnings had bigger nonfarm incomes, whereas those with bigger farms and labor earnings had smaller nonfarm incomes. Farmers with low farm incomes had secondary occupations so that they could raise the total income needed for their family support.

The operator's total labor earnings were obtained by adding the nonfarm income to the operator's labor earnings (table 8).

Income of other members of the family. The income of other members of the family included the unpaid family labor, which was charged as an expense, and the family nonfarm income from buying and selling farm products, operating stores, and working as laborers (table 8).

Amount available for family living. The total family income includes the operator's total labor earnings, the unpaid family labor, and the family nonfarm income. When the family income is added to the interest on inventory, the resultant sum represents the amount available for family living. Of the amount available for family living (table 8), the operator earned 87.2 per cent. The part-owners had the biggest amount; the owner-operators, the smallest. The difference, however, was very slight. The size of the farm influenced greatly the labor earnings, which contributed the biggest proportion to the amount available for family living. The smaller tenant-operated farms had smaller amounts available for family living, and the bigger tenant-operated farms had bigger amounts (table 9).

CONCLUSION

This survey shows that the income of rice farmers in the Mahas-Maitim area is very small. The small size of the farms is the most important single factor responsible for the small income of rice farmers and their unsatisfactory standard of living. Lack of irrigation, high interest rates on farm loans, and high rent for work animals influence to some extent the farmer's income. Because of lack of capital, the farmers cannot acquire work animals and meet their operating expenses. The tenants do not possess the necessary collateral for securing loans from commercial banks. Moreover, the amount invested in the farms the tenants operate is very small. The limited income from farming makes it very difficult or almost impossible for the tenants to become landowners. It is, therefore, imperative that government agencies, such as the Agricultural Credit and Cooperative Financing Administration, the rural banks, the agricultural extension service, and the irrigation service units, work hand in hand with the farmers with a view to improving the farmer's productive efficiency and increasing his income.

TABLE 1

Average capital investment of 99 rice farms by tenure

ITEM	84 TENANT FARMS	9 PARTLY OWNED FARMS	4 OWNER-OPERATED FARMS	ALL FARMS
	pesos	*pesos*	*pesos*	*pesos*
Land:				
Landlord	10,238	4,611	—	9,106
Operator	—	7,338	4,118	917
Buildings:				
Operator	340	550	358	360
Tools:				
Operator	86	127	100	91
Work animals:				
Landlord [a]	21	17	—	19
Operator	359	487	367	371
Other livestock:				
Operator	59	40	45	56
Total:				
Landlord	10,259	4,628	—	9,125
Operator	844	8,542	4,988	1,795
Total capital investment	11,103	13,170	4,988	10,920

[a] Only a few cases.

TABLE 2

Farm area and capital investment in land of 99 rice farms by tenure

TYPE OF LAND AND VALUE	TENANT	PARTLY OWNED	OWNER-OPERATED	ALL FARMS
Lowland:				
Area (hectares)	1.87	1.83	0.83	1.80
Value (pesos)	10,042	5,500	2,833	9,192
Upland:				
Area (hectares)	0.07	0.35	0.29	0.11
Value (pesos)	161	972	583	260
Other land:				
Area (hectares)	0.01	0.86	0.15	0.10
Value (pesos)	35 [a]	5,477	702	571
Total farm area:				
Area (hectares)	1.95	3.04	1.27	2.01
Value (pesos)	10,238	11,949	4,118	10,023
Total effective crop area (hectares)	3.49	3.31	1.50	3.35

[a] Value is low because only one farm is involved.

TABLE 3

Utilization of effective crop area of 99 rice farms by tenure

CROP	TENANT	PARTLY OWNED	OWNER-OPERATED	ALL FARMS
	hectares	*hectares*	*hectares*	*hectares*
Lowland rice	3.39	2.07	1.00	3.13
Upland rice	0.03	0.30	0.25	0.07
Vegetables and minor crops	0.06	0.18	0.12	0.07
Coconut	0.01	0.76	0.13	0.08
Total	3.49	3.31	1.50	3.35

TABLE 4

Average rice production in cavans of 99 rice farms by tenure

DISTRIBUTION OF HARVEST	TENANT	PARTLY OWNED	OWNER-OPERATED	ALL FARMS
Lowland:				
Harvester's share	33.0	13.3	11.4	29.9
Landlord's share	82.0	21.8	—	71.5
Operator's share	81.7	32.8	51.7	75.5
Total production	196.7	67.9	63.1	176.9
Yield to a hectare a year	105.3	37.1	75.5	98.2
Yield to a hectare for each planting	57.9	32.2	58.2	56.4
Upland: [a]				
Harvester's share	0.2	0.7	0.7	0.3
Landlord's share	0.3	0.5	—	0.3
Operator's share	0.5	2.1	2.5	0.7
Total production	1.0	3.3	3.2	1.3
Yield to a hectare	12.9	9.4	10.9	11.9
Total rice produced	197.7	71.2	66.3	178.2

[a] Only a few farms.

TABLE 5

Average rice production in cavans of 84 tenant-operated farms by size of farm

	FARM AREA IN HECTARES			ALL FARMS
	0.5-1.4	1.5-2.0	2.1-5.0	
Lowland:				
Harvester's share	15.5	31.4	51.5	33.0
Landlord's share	38.2	78.9	127.4	82.0
Operator's share	38.2	77.1	128.5	81.7
Total production	91.9	187.4	307.4	196.7
Yield to a hectare a year	110.3	109.6	101.5	105.3
Yield to a hectare for each planting	59.4	56.2	58.7	57.9
Upland: [a]				
Harvester's share	0.2	0.1	0.3	0.2
Landlord's share	0.4	0.1	0.5	0.3
Operator's share	0.6	0.1	0.6	0.5
Total production	1.2	0.3	1.4	1.0
Yield to a hectare	29.1	10.0	9.0	12.9
Total rice produced	93.1	187.7	308.8	197.7

[a] Only a few farms.

TABLE 6

Number of livestock to a farm of 99 rice farms by tenure

LIVESTOCK	TENANT	PARTLY OWNED	OWNER-OPERATED	ALL FARMS
Carabaos	1.5 [a]	2.1	1.7	1.6
Goats	[b]	—	—	[b]
Horses	[b]	—	—	[b]
Boars	0.1	0.2	0.7	0.1
Sows	0.1	0.1	—	0.1
Young pigs	0.6	0.7	—	0.6
Hens	3.0	3.1	3.3	3.0
Pullets	1.8	2.3	1.2	1.8
Roosters	1.1	1.9	0.8	1.1
Young chickens	5.6	9.7	2.7	5.8
Ducks	4.2	0.3	5.8	4.0

[a] Includes borrowed carabao and landlord's carabao.
[b] Less than 0.05.

TABLE 7

Average sale of livestock by 99 rice farms by tenure

LIVESTOCK AND LIVESTOCK PRODUCT SOLD	TENANT	PARTLY OWNED	OWNER-OPERATED	ALL FARMS
	pesos	*pesos*	*pesos*	*pesos*
Carabaos	27.73	—	50.00	26.56
Horses	1.25 [a]	—	—	1.06
Boars	6.84	—	—	5.81
Sows	2.47	—	—	2.10
Young pigs	2.48	0.78	—	2.18
Hens	0.79	2.33	6.67	1.28
Pullets	3.40	2.22	—	3.09
Roosters	1.02	2.00	—	1.05
Ducks	2.17		—	1.84
Eggs	43.56	0.45	3.83	37.25
Total livestock sold	91.71	7.78	60.50	82.22

[a] Figure is low because only one farm sold horses.

TABLE 8

Average farm business summary of 99 rice farms by tenure

	TENANT	PARTLY OWNED	OWNER-OPERATED	ALL FARMS
	pesos	*pesos*	*pesos*	*pesos*
Operator's average inventory				
Land	—	7,338	4,118	917
Building	340	550	358	360
Tools	86	127	100	91
Work animals	359	487	367	371
Other livestock	59	40	45	56
Total average inventory	844	8,542	4,988	1,795
Less fixed assets on which interest was paid	—	822	—	75
Net average inventory	844	7,720	4,988	1,720
Farm receipts				
Crops (excluding fruits and vegetables):				
Sold by operator	554	496	180	526
Landlord's share	824	224	—	719
Harvester's share	332	140	121	302
Fruits and vegetables:				
Sold by operator	16	57	118	25
Landlord's share	5	3	—	5
Livestock sold by operator	92	8	61	82
Increase in inventory	63	113	99	71
Total farm receipts	1,886	1,041	579	1,730
Farm expenses				
Harvester's share	332	140	121	302
Landlord's share of all crops	829	227	—	724
Purchased tools and equipment	4	19	—	5
Purchased livestock	62	42	44	59
Miscellaneous cash expenses	145	124	140	143
Hired labor	16	25	15	17
Unpaid family labor	12	27	10	13
Total farm expenses	1,400	604	330	1,263
Net farm income	486	437	249	467
Interest on inventory	50	463	299	103
Labor income	436	−26	−50	364
Farm privileges	391	442	510	403
Operator's labor earnings	827	416	460	767
Operator's nonfarm income	60	107	102	67
Operator's total labor earnings	887	523	562	834
Unpaid family labor	12	27	10	13
Other family nonfarm income	14	133	66	28
Total family income	913	683	638	875
Interest on inventory [a]	30	430	278	81
Amount available for family living	943	1,113	916	956

[a] Does not include interest on dwellings.

TABLE 9

Average farm business summary of 84 tenant-operated farms by size of farm

	FARM AREA IN HECTARES			ALL FARMS
	0.5-1.4	1.5-2.0	2.1-5.0	
	pesos	*pesos*	*pesos*	*pesos*
Operator's average inventory				
Building	221	299	497	340
Tools	71	86	102	86
Work animals	278	391	405	359
Other livestock	45	62	67	59
Total inventory	615	838	1,071	844
Farm receipts				
Crops (excluding fruits and vegetables):				
Sold by operator	227	516	909	554
Landlord's share	386	791	1,281	824
Harvester's share	157	315	518	332
Fruits and vegetables:				
Sold by operator	3	9	34	16
Landlord's share	—	5	10	5
Livestock sold by operator	62	109	102	92
Increase in inventory	65	65	62	63
Total farm receipts	900	1,810	2,916	1,886
Farm expenses				
Harvester's share	157	315	518	332
Landlord's share of all crops	386	796	1,291	829
Purchased tools and equipment	5	3	8	4
Purchased livestock	44	77	63	62
Miscellaneous cash expenses	100	162	170	145
Hired labor	12	8	27	16
Unpaid family labor	7	9	19	12
Total farm expenses	711	1,370	2,096	1,400
Net farm income	189	440	820	486
Interest on inventory	36	50	63	50
Labor income	153	390	757	436
Farm privileges	240	387	542	391
Operator's labor earnings	393	777	1,299	827
Operator's nonfarm income	118	46	20	60
Operator's total labor earnings	511	823	1,319	887
Other family nonfarm income	7	9	19	12
Unpaid family labor	7	8	25	14
Total family income	525	840	1,363	913
Interest on inventory [a]	23	32	33	30
Amount available for family living	548	872	1,396	943

[a] Does not include interest on dwellings.

TABLE 10

Average utilization of rice crop by 99 rice farmers

TENURE	OPERATOR'S SHARE	AMOUNT SOLD [a]		AMOUNT USED AT HOME	
	cavans	*cavans*	*per cent*	*cavans*	*per cent*
Tenant farms:					
0.5–1.4 hectares	38.9	20.5	53	18.4	47
1.5–2.0 hectares	77.2	46.7	60	30.5	40
2.1–5.0 hectares	129.1	85.9	67	43.2	33
All tenant-operated farms	82.2	51.4	63	30.8	38
Partly owned farms	34.9	2.7	8	32.2	92
Owner-operated farms	54.2	12.0	22	42.2	78
All farms	76.2	44.6	59	31.6	41

[a] The prevailing price was ₱10.00 a cavan; the average price was ₱10.68 a cavan.

TABLE 11

Cash expenses in pesos of 99 rice farms by tenure

EXPENSE ITEM	TENANT	PARTLY OWNED	OWNER-OPERATED	ALL FARMS
Fertilizer	13.65	8.61	10.88	13.03
Cash rent for work animals	31.98	—	3.33	27.35
Rope	5.42	6.69	4.17	5.46
Branding fee	0.44	1.67	1.03	0.59
Interest on farm loan	33.57	65.11	43.33	37.05
Irrigation fee	9.22	—	—	7.83
Building materials	50.16	33.55	70.00	49.87
Repair of tools	0.32	6.56	7.07	1.29
Taxes	0.12	2.08	—	0.29
Hired man labor	11.66	21.62	15.10	12.78
Hired animal labor	4.21	3.47	—	3.89
Total cash expenses	160.75	149.36	154.91	159.43

TABLE 12

Cash expenses in pesos of 84 tenant-operated farms by size of farm

	FARM AREA IN HECTARES			ALL FARMS
	0.5-1.0	1.5-2.0	2.1-5.0	
Fertilizer	7.12	12.50	21.15	13.65
Cash rent for work animals	11.48	48.36	34.81	31.98
Rope	4.95	5.59	5.71	5.42
Branding fee	0.22	0.72	0.36	0.44
Interest on farm loan	26.74	42.39	31.06	33.57
Irrigation fee	5.00	10.03	12.46	9.22
Building materials	44.56	41.44	64.62	50.16
Repair of tools	—	0.52	0.43	0.32
Taxes	0.37	—	—	0.12
Hired man labor	8.61	6.35	20.11	11.66
Hired animal labor	3.85	1.55	7.32	4.21
Total cash expenses	112.90	169.45	198.03	160.75

TABLE 13

Value in pesos of farm privileges of 99 rice farms by tenure

FARM PRIVILEGE	TENANT	PARTLY OWNED	OWNER-OPERATED	ALL FARMS
Use of dwelling	55.07	78.20	51.50	56.95
Crops used at home	310.02	327.22	427.42	318.70
Fruits and vegetables used at home	1.87	2.56	1.33	1.90
Livestock and livestock products used at home	24.51	34.67	29.33	25.72
Total farm privileges	391.47	442.65	509.58	403.27

TABLE 14

Value in pesos of farm privileges of 84 tenant-operated farms by size of farm

FARM PRIVILEGE	FARM AREA IN HECTARES			ALL FARMS
	0.5-1.4	1.5-2.0	2.1-5.0	
Use of dwelling	34.25	48.45	81.98	55.07
Crops used at home	185.22	306.34	434.14	310.02
Fruits and vegetables used at home	1.41	1.72	2.46	1.87
Livestock and livestock products used at home	19.26	30.40	23.47	24.51
Total farm privileges	240.14	386.91	542.05	391.47

TABLE 15

Average value in pesos of livestock used in 99 farm homes by tenure

LIVESTOCK AND LIVESTOCK PRODUCT USED	TENANT	PARTLY OWNED	OWNER-OPERATED	ALL FARMS
Boars	2.74	4.45	10.00	3.33
Young pigs	10.91	10.00	—	10.17
Hens	2.86	4.33	8.00	3.30
Pullets	5.22	6.89	7.33	5.50
Roosters	1.06	7.67	1.50	1.69
Eggs	1.71	1.33	2.50	1.73
Total	24.50	34.67	29.33	25.72

TABLE 16

Relation of effective crop area to labor earnings of 84 tenant-operated farms [a]

LABOR EARNINGS IN PESOS	EFFECTIVE CROP AREA IN HECTARES							ALL FARMS
	Less 1	1-1.9	2-2.9	3-3.9	4-4.9	5-5.9	6 & over	
1,500 and over	—	—	—	—	—	3	6	9
1,200–1,499	—	—	—	3	3	3	3	12
900–1,199	—	1	—	3	4	1	2	11
600–899	—	2	3	6	4	3	—	18
300–599	—	6	8	5	4	—	—	23
Less than 300	2	4	4	1		—	—	11
All farms	2	13	15	18	15	10	11	84

[a] Frequency distribution by number of farms. Coefficient of correlation = 0.754; coefficient of determination = 0.568.

OUTSTANDING VARIETIES AND FORMS OF PUMMELO, CITRUS GRANDIS (LINN.) OSBECK, IN SOME TOWNS OF NUEVA ECIJA [1]

FLORENCIO R. FRANCIA

WITH TWO TEXT FIGURES

None of the varieties and forms studied could compare in eating quality with Siam, the control, in the opinion of three judges. There was no apparent agreement between the chemical analyses and the organoleptic test. Significant differences were found among the specimens studied in thickness of rind, number of seeds, weight of seeds, total reducing sugar, and percentage of edible portion. The trees examined appeared vigorous, prolific, and resistant to pests and diseases in spite of the lack of systematic care.

The present survey was conducted to search for varieties and forms of pummelo reputed to be of good quality and to compare the different forms collected. The study took place from December, 1952, to February, 1954, in some towns of Nueva Ecija and in the Department of Agronomy and Chemistry, UP College of Agriculture.

MATERIALS AND METHODS

A total of 230 bearing trees was sampled in nine towns and four barrios of Nueva Ecija (table 1a). The towns visited were Guimba, Laur, Gapan, Cabanatuan City, Muñoz, San Jose, Talavera, Cuyapo, and Santa Rosa; the barrios were Bunol, Maturanoc, and Nanglabrahan in the municipalities of Guimba and Bakal in Muñoz.

Preliminary sampling was made of the fruits in the field. The trees were numbered and catalogued. At least five fruits were collected from each of the best 10 pummelo trees, packed in separate containers, properly labeled, and brought to the College of Agriculture for pomological study and chemical analysis.

Each of the five fruits from each tree (fig.1) was studied for size, weight, weight and thickness of rind, weight of rag, number and weight of seeds, pulp-juice ratio, texture of pulp, and taste. The latter was determined by a panel of three judges. The color of the rind and the pulp was observed. The percentage of edible portion was computed from the individual weights of the other parts studied.

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[1] Central Experiment Station Contribution No. 1784. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1954. Prepared in the Department of Agronomy under the direction of Professor Leon G. Gonzalez.

Fig. 1.—Upper panel shows the natural shape of pummelo fruits. Lower panel shows the longitudinal cross-sections of pummelo fruits. (*Photographed by Dr. Julian Banzon of the Photographic Division.*)

The five selected fruits from each tree were analyzed [2] for juice-pulp ratio, amount of titratable acidity [3] and sugar content. For the juice-pulp ratio one or two segments from each of the fruits were tested. The pulp was separated from the rag and weighed, and the juice was extracted with a Carver hydraulic press. After the juice had been extracted the pulp was again weighed and the amount of juice computed.

The extracted juice was diluted to 100 ml. in the proportion of one part juice to three parts distilled water by volume. Ten ml. pure juice was used to titrate with .1 N NaOH. Three trials were made and the results were reported as milliliters of .1 N NaOH per 100 ml. of undiluted juice.

Sugar content was analyzed by the Lane-Eyon general volumetric method. Soxhlet modification of Fehling solution was used, and the results were reported in milligrams per 100 ml. of pure juice.

RESULTS AND DISCUSSION

The pummelos (designated according to owner) were ranked by the panel of judges in their order of preference as follows: Siam

[2] All chemical analyses were made in accordance with the procedures of the Association of Official Agricultural Chemists. They were performed under the supervision of Professor Leopoldo Villanueva, Department of Agricultural Chemistry.

[3] All the pH meters in the College were not operating when the work was done, and the colorimetric method was not accurate enough.

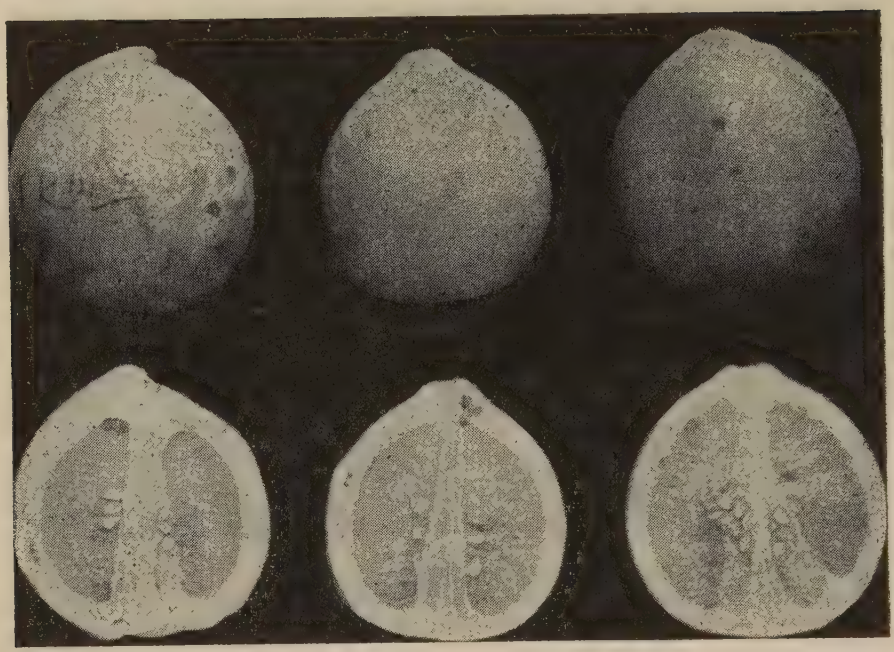

Fig. 2.—Siamese variety and an unknown variety of pummelo. (*Photographed by Dr. Julian Banzon of the Photographic Division.*)

(fig.2), P. Garcia (Form 1), CLAC (Form 1), P. Garcia (Form 2), CLAC (Form 2), T. Romano, L. Ramos, A. Rigos, and I. Benito. In the opinion of the judges, therefore, none of the specimens studied was any better than Siam, the control. Furthermore, no correlation could be found between the organoleptic test and the chemical analyses for total invert sugar, titratable acidity, and sugar-acid ratio (table 11).

The analyses of variance of the data obtained for thickness of rind (table 3), number of seeds (table 6), weight of seeds (table 7), and total reducing sugar (table 10) gave significant differences. The mean thickness of rind was 1.48 centimeters, the mean number of seeds was 83.06 to a fruit, the mean weight of seeds was 9.33 grams, and the mean amount of total reducing sugar was 474.53 ml. per 100 ml. of undiluted juice.

The differences in percentage of edible portion of the fruits were significant at the 5 per cent level, indicating that selection on the basis of this character is possible. No significant differences were obtained in weight of whole fruit (table 2), weight of rind (table 4), weight of rag (table 5), and titratable acidity (table 9).

Several points of interest were noted during the survey. In general, though most of the trees examined in Nueva Ecija were not given the systematic care now practiced in modern commercial or-

chards such as those found in the provinces of Laguna and Batangas, the majority of the pummelo trees were much more vigorous and appeared more healthy. Some of the trees examined were said to be over fifty years old but were still fruitful, despite the fact that no commercial fertilizer had been added to them. The trees were almost free from citrus canker quite common in Batangas; the fruits were less attacked by rind borer and, according to the growers, were not bothered by any other diseases and pests common in commercial plantations in Laguna and Batangas. Another point noticed was the esteem in which the inhabitants seemed to hold the pummelo trees. Few yards did not contain at least one or two pummelo trees interplanted with other fruit plants. In a place like Nueva Ecija where conditions for growth of the pummelos are favorable and the people like the fruit, more aid to the farmers in the form of better kinds of planting materials should be given.

TABLE 1a

Owners and location of 10 selected varieties and forms of pummelo

TREE NO.	OWNER	ADDRESS	RANK [a]
I	P. Garcia (Form 1)	Cabanatuan City	2nd
II	Abundio Rigos	Laur	6th
III	P. Garcia (Form 2)	Cabanatuan City	4th
IV	CLAC (Form 1)	Muñoz	3rd
V	CLAC (Form 2)	Muñoz	5th
VI	Siam (control)		1st
VII	T. Romano	Guimba	8th
VIII	M. Romano	Guimba	9th
IX	Lorenzo Ramos	Gapan	7th
X	I. Benito	San Jose	10th

[a] Based on decision of panel of judges.

TABLE 1b

Panel ranking of the taste of 10 outstanding forms and varieties of pummelo

FORMS AND VARIETIES AND OWNERS	PLACING BY PANEL						TOTAL POINTS
	Rank	Points (1-10)	Rank	Points (1-10)	Rank	Points (1-10)	
P. Garcia (Form 1)..	2	9	1	10	5	6	25
A. Rigos	7	4	8	3	9	2	9
P. Garcia (Form 2)..	4	7	3	8	3	8	23
CLAC (Form 1)	3	8	4	7	2	9	24
CLAC (Form 2)	5	6	6	5	4	7	18
Siam (control)	1	10	2	9	1	10	29
T. Romano	6	5	5	6	6	5	16
M. Romano	10	1	9	2	7	4	7
L. Ramos	8	3	7	4	8	3	10
I. Benito	9	2	10	1	10	1	4

TABLE 2

Weight of the whole fruits in grams

FRUIT	NUMBER OF TREE										TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X	
1	851.8	990.1	1,021.0	935.0	1,028.0	1,005.0	970.0	902.0	1,082.0	873.0	9,657.9
2	972.3	953.7	1,099.6	961.0	868.0	980.0	872.9	839.8	997.6	893.0	9,437.9
3	989.2	874.5	1,089.0	892.8	963.0	1,001.0	971.2	877.0	887.0	896.0	9,440.7
4	876.0	891.0	996.5	892.5	864.0	988.0	897.0	925.0	789.0	892.0	9,011.0
5	862.3	972.0	930.5	897.0	978.0	974.0	989.8	1,027.8	796.0	883.0	9,310.4
Total	4,551.6	4,681.3	5,136.6	4,578.3	4,701.0	4,948.0	4,700.9	4,571.6	4,551.6	4,437.0	46,857.9
Mean	910.32	936.26	1,027.32	915.66	940.20	989.60	940.18	914.32	910.32	887.40	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	78,993.5	8,777.1	2.0836	2.12	2.88
Fruits	40	168,497.29	4,212.43			
Total	49	247,490.79				

TABLE 3

Thickness of rind of pummelo fruits in centimeters

FRUIT	NUMBER OF TREE										TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X	
1	2.0	2.2	1.8	1.5	1.4	1.6	1.2	1.2	1.2	1.2	15.3
2	1.9	1.8	1.5	1.8	1.7	1.4	1.1	1.1	1.3	1.3	14.9
3	2.1	1.5	2.6	1.8	1.4	1.3	1.1	1.3	1.4	1.1	15.6
4	1.8	1.6	1.7	2.1	1.1	1.2	1.3	1.2	1.1	1.0	14.1
5	1.5	2.1	1.9	1.5	1.2	1.1	1.4	1.1	1.2	1.3	14.3
Total	9.3	9.2	9.5	8.7	6.8	6.6	6.1	5.9	6.2	5.9	74.2
Mean	1.86	1.84	1.90	1.74	1.36	1.32	1.22	1.18	1.24	1.18	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	4.32	0.48	9.06	2.12	2.88
Fruits	40	2.11	0.053			
Total	49	6.43				

L.S.M.D. at 5% level = .292
at 1% level = .392

TABLE 4

Weight of the rind of pummelo fruits in grams

FRUIT	NUMBER OF TREE										TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X	
1	172.0	198.0	201.0	206.0	188.0	181.0	138.0	142.0	172.0	185.0	1,783.0
2	182.7	205.0	124.0	131.0	134.0	156.0	207.0	207.0	184.0	176.0	1,706.7
3	178.3	183.0	124.0	127.0	130.0	181.0	136.0	141.0	206.0	149.0	1,555.3
4	163.0	187.0	132.0	157.0	129.0	135.0	120.0	139.0	189.0	138.0	1,489.0
5	168.0	158.0	154.0	143.0	201.0	139.0	193.0	196.0	137.0	134.0	1,623.0
Total	864.0	931.0	735.0	764.0	782.0	792.0	794.0	825.0	888.0	782.0	8,153.0
Mean	172.80	186.20	147.00	152.80	156.40	158.40	158.80	165.20	177.60	156.40	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	7,990.82	887.87	1.1106	2.12	2.88
Fruits	40	31,979.18	799.48			
Total	49	39,970.00				

TABLE 5

Weight of the rag of pummelo fruits in grams

FRUIT	NUMBER OF TREE										TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X	
1	102.0	102.0	89.9	101.0	103.0	93.0	101.0	91.0	85.0	83.0	950.9
2	93.0	85.0	101.2	92.0	92.0	103.0	99.0	94.1	90.0	85.0	934.3
3	87.0	99.0	106.0	96.0	99.5	94.0	99.6	89.0	93.0	96.0	959.1
4	98.7	88.0	101.5	101.0	95.0	96.0	96.0	85.0	106.0	84.0	951.2
5	93.7	109.0	99.0	99.4	85.0	86.0	101.0	107.0	104.0	96.0	980.1
Total	474.4	483.0	497.6	489.4	474.5	472.0	496.6	466.1	478.0	444.0	4,775.6
Mean	94.88	96.60	99.52	97.88	94.90	94.40	99.32	93.22	95.60	88.80	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	448.39	49.821	1.06	2.12	2.88
Fruits	40	1,875.16	46.879			
Total	49	2,323.55				

TABLE 6

Number of seeds in the pummelo fruits

FRUIT	NUMBER OF TREE										TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X	
1	76.0	97.0	105.0	108.0	98.0	103.0	97.0	53.0	85.0	101.0	923.0
2	82.0	107.0	53.0	115.0	83.0	98.0	109.0	81.0	83.0	96.0	907.0
3	53.0	67.0	64.0	92.0	88.0	102.0	82.0	59.0	60.0	63.0	730.0
4	58.0	61.0	68.0	87.0	96.0	89.0	87.0	63.0	73.0	70.0	752.0
5	76.0	53.0	101.0	123.0	102.0	93.0	93.0	56.0	84.0	73.0	854.0
Total	345.0	385.0	391.0	525.0	467.0	485.0	468.0	312.0	385.0	403.0	4,166.0
Mean	69.00	77.00	78.20	105.00	93.40	97.00	93.60	62.40	77.0	80.60	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	8,103.28	900.364	4.063	2.12	2.88
Fruits	40	8,863.60	221.59			
Total	49	16,966.88				

L.S.M.D. at 5% level = 19.037
at 1% level = 25.471

TABLE 7

Weight of seeds of pummelo fruits in grams

FRUIT	NUMBER OF TREE										FRUIT
	I	II	III	IV	V	VI	VII	VIII	IX	X	
1	10.3	11.9	12.6	13.0	12.0	12.1	11.9	5.0	11.8	12.1	112.7
2	11.5	12.9	5.6	14.0	11.6	11.9	13.0	11.0	11.6	11.5	114.6
3	5.0	8.0	8.1	10.0	11.8	12.8	11.5	5.7	7.8	7.9	88.6
4	6.2	7.8	9.0	10.6	10.0	10.6	12.6	7.0	9.3	9.0	92.1
5	10.3	8.6	12.1	16.0	12.1	12.0	10.0	6.1	11.7	9.8	108.7
Total	43.3	49.2	47.4	63.6	57.5	59.4	59.0	34.8	52.2	50.3	516.7
Mean	8.66	9.84	9.48	12.72	11.50	11.88	11.80	6.96	10.44	10.06	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	134.19	14.910	3.4614	2.12	2.88
Fruits	40	172.30	4.3075			
Total	49	306.49				

L.S.M.D. at 5% level = 2.667
at 1% level = 3.569

TABLE 8

Percentage of edible portion of pummelo fruits

FRUIT	NUMBER OF TREE										TOTAL
	I	II	III	IV	V	VI	VII	VIII	IX	X	
1	66.62	69.50	70.27	65.77	70.52	71.53	74.13	73.61	75.15	67.91	705.01
2	70.45	68.25	79.01	75.33	72.62	74.39	74.80	63.32	71.22	69.48	718.87
3	72.67	66.83	78.13	73.90	74.94	71.24	74.55	73.12	65.41	71.77	722.56
4	63.25	68.26	75.30	69.90	72.91	75.54	74.57	75.02	61.43	74.10	710.28
5	68.45	72.16	71.50	71.19	69.51	75.66	69.28	69.92	61.79	72.84	702.30
Total	341.44	345.00	374.21	356.09	360.50	368.36	367.33	354.99	335.00	356.10	3,559.02
Mean	68.28	69.00	74.84	71.21	72.10	73.67	73.46	71.00	67.00	71.22	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	9	281.59	31.29	2.4992	2.12	2.88
Fruits	40	500.64	12.52			
Total	49	782.23				

L.S.M.D. at 5% level = 4.520

TABLE 9

Amount of titratable acid in undiluted pummelo juice per 100 ml. of .1 N NaOH

TRIAL	NUMBER OF TREE						TOTAL
	I	II	III	IV	V	VI	
1	128.00	120.80	122.40	136.00	160.71	198.88	866.79
2	96.27	109.06	133.86	141.86	136.00	162.67	779.72
3	122.00	138.00	124.00	135.80	178.00	154.60	852.40
Total	346.27	367.86	380.26	413.66	474.71	516.15	2,498.91
Mean	115.42	122.62	126.75	137.89	158.24	172.05	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	5	7,312.68	146.25	0.5668	3.11	5.06
Fruits	12	3,096.25	258.02			
Total	17	10,408.93				

TABLE 10

Amount of invert sugar present in the juice of pummelo expressed in milliliters of reducing sugar per 100 ml. of undiluted juice

TRIAL	NUMBER OF TREE						TOTAL
	I	II	III	IV	V	VI	
1	416.66	648.14	461.49	388.88	422.70	615.33	2,953.20
2	423.31	723.73	434.02	416.66	502.87	629.95	3,130.54
3	432.09	418.89	479.71	405.09	538.13	617.94	2,891.85
Total	1,272.06	1,790.76	1,375.22	1,210.63	1,463.70	1,863.22	8,975.59
Mean	424.02	596.92	458.41	403.54	487.90	621.07	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Trees	5	122,983.41	24,596.68	4.9954	3.11	5.06
Fruits	12	59,086.03	4,923.84			
Total	17	182,069.44				

L.S.M.D. at 5% level = 130.50

TABLE 11

Sugar-acid ratio

OWNER	SUGAR	ACID	RATIO
Garcia I	424.02	115.45	3.67:1
Rigos	596.92	122.62	4.87:1
Garcia II	458.40	126.75	3.62:1
CLAC I	403.54	137.88	2.93:1
CLAC II	484.56	158.23	3.06:1
Control	621.07	172.03	3.61:1

SOME PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS IN A COCONUT PLANTATION IN GUMACA, QUEZON [1]

MARINA L. ESCRITOR

The textural grade of the surface of the good-yielding soils was sandy clay loam, and that of the subsoil was clay loam. The surface of the poor-yielding soils, on the other hand, was a coarse sandy loam, and the subsoil, a sandy clay loam. In both types of soils, the subsoil had a higher water-holding capacity than the surface soil. The total nitrogen, available phosphorus, exchangeable calcium and potassium, and organic-matter content were higher in the high-yielding soils than in the poor-yielding soils. The magnesium content was higher in the low-yielding soils; the pH value was the same in both lots.

The coconut water from the high-yielding trees had a higher potash content than that from the low-yielding trees. The potash content of coconut water increased with a corresponding increase in the amount of available potassium in the soil. All other conditions being equal, the low yield of coconuts might be readily attributed to the small amount of available potassium in the soil.

David (1949) stated that fertilizers containing nitrogen, potash, and phosphorus improve the growth of young coconut trees and induce them to bear early. Potash, which young coconut trees need most, can be supplied in the form of ashes, manures, or commercial fertilizers. Nitrogen can be obtained from green manure, and phosphorus from basic slag.

Salgado (1951) concluded that the potash content of coconut water rises with an increase in the potash content of the soil and provides an index of the expected yield.

According to Peech and Bradfield (1943), Van Italli in 1938 reported that in soils with variable exchangeable cations, the mutual cation replacement takes place in the plant in nearly equivalent amounts. The largest amount absorbed is potassium. Sodium, magnesium, and calcium decrease progressively in the order given, but magnesium distinctly depresses the uptake of potassium. Peech and Bradfield pointed out that calcium does not affect appreciably the uptake of potassium by the plant, whereas potassium suppresses the uptake of both calcium and magnesium.

Albrecht (1943) observed that the amount of exchangeable calcium in the soil colloid may be ten times as great as that of exchangeable potassium.

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[1] Central Experiment Station Contribution No. 1785. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, March, 1954. Prepared in the Department of Soils under the direction of Associate Professor Nicolas L. Galvez.

Rola and Galvez (1949) stated that the soil reaction is a single-value soil property capable of influencing the ability of plants to make use of the nutrient in the soil.

Breland, Bertramson, and Borland (1930) suggested that the ability of different soils to release potassium for plant consumption is a dominant factor in the nutrition of plants and is a characteristic of each soil type.

Galvez and Pagador (1951) reported that organic matter, a contributing factor to soil fertility, and nitrogen content are significantly lower in cultivated than in forest soils.

This study was conducted in the Department of Soils from April, 1953, to March, 1954, to determine the physical and chemical properties of soils supporting good and poor stands of coconuts.

MATERIALS AND METHODS

Description of plantation. An old 1-hectare coconut plantation in the barrio of Rosario, Gumaca, Quezon, was studied. Approximately one-half of the area had a good stand of coconut trees, and the other half, a poor stand. No fertilizer had been applied since the trees were planted. Care in the form of cutting down of trees and tall grasses and burning of trash was given the plantation.

The field was entirely covered with grasses, such as culapé (*Paspalum conjugatum* L.), makahiya (*Mimosa pudica* L.), and mutha (*Cyperus rotundus* L.). Buri palms and ipil-ipil (*Leucaena glauca* [L.] Benth.) were grown on some parts, and the boundaries were planted with madre de cacao (*Gliricidia sepium* [Jack.] Steud). On the plantation were 168 good-yielding and full-bearing coconut trees from which 60 to 90 nuts to a tree were harvested annually. About 166 to 200 kilograms of copra were obtained from every one thousand nuts, the annual production amounting to 2016 to 3024 kilograms of copra. The poor-yielding coconut trees produced 30 to 60 nuts each year. About 100 to 145 kilograms of copra were obtained from every one thousand nuts, the yearly produce being 315.0 to 913.5 kilograms of copra.

The entire area had dark-brown surface soil and light-brown subsoil. The surface soil had an average depth of 4.05 inches. It was loose and friable when moist. The subsoil was hard when dry and slightly sticky when wet.

Collection of soil samples. The area was divided into two sections, and each section was further subdivided into 10 lots. Twenty-four borings, which made up a composite sample, were collected at random approximately four to five meters apart between the coconut trees of each lot. Before the samples were taken, the accumulated plant materials on the surface of the ground were scraped off to prevent the contamination of the organic materials in the sample. The surface soils and subsoils obtained were air-dried, pulverized, passed through a 2-mm. sieve, and then placed in jars.

Physical analyses. The method of determining soil texture worked out by Bouyoucos (1927) was followed in this study. The water-holding capacity was calculated in accordance with the method of Piper (1947).

Chemical analyses. The organic-matter content was determined by the permanganate method of Eckstein, Jacob, and Alten (1931), and the total nitrogen, by the microkjeldahl method described by the Association of Official Agricultural Chemists (1945). The pH value of the soil was calculated with the use of the La Motte Universal pH outfit with brom thymol blue as indicator. The amounts of exchangeable calcium and potassium were ascertained by the methods described by Wolf and Ichisaka (1947), and the amount of magnesium was determined by the method of Peech and English (1944). The amount of available phosphorus was determined according to the method of Truog (1930). The potash content of the water of 10 mature coconuts was ascertained in accordance with the method described by the Second Commission of the International Society of Soil Science as modified by Blanck and Reiser (1928). Four such determinations were made: two for the coconuts from high-yielding trees and two for the coconuts from poor-yielding trees.

RESULTS AND DISCUSSION

Texture. The sand content of the surface of good-yielding soils was greater than that of the corresponding subsoils (table 1). There was no variation in the sand content of poor-yielding soils (table 2). The amount of clay in the subsoil was higher than that in the surface soil in both good- and poor-yielding soils (tables 3 and 4). The surface soil and the subsoil of both types had the same silt components (tables 5 and 6). The surface soil of the high-yielding section of the plantation was sandy clay loam, and the subsoil, clay loam. The textural grade of the surface soil of the low-producing section was coarse sand loam; that of the subsoil, clay loam.

Water-holding capacity. The average water-holding capacity of the good-yielding surface soil was 34.96 per cent; that of the subsoil was 42.40 per cent (table 7). Parallel results were obtained with the poor-yielding soils: the subsoil had a higher water-retention capacity, 38.47 per cent, than the surface soil, which had 35.32 per cent (table 8).

Organic-matter content. The organic matter in the soils varied between samples (table 9). The high-producing soils contained a bigger amount of organic matter, an average of 3.15 per cent, than the low-producing soils, which had an average of 2.38 per cent.

Nitrogen content. The average total nitrogen content of the high-yielding soils was 0.135 per cent, and that of the poor-yielding soils, 0.105 per cent (table 10). The difference was highly significant. Since the native source of nitrogen is soil organic matter, it is safe to assume that the higher the organic matter present, the higher the total nitrogen content.

Available phosphorus content. The average amount of available phosphorus in the good-yielding coconut soils was 46.22 ppm., which was significantly higher than the 32.49 ppm. of the low-yielding soils (table 11).

Exchangeable bases. The amount of exchangeable potassium, an essential element in the development of chlorophyll, in starch formation, and in the translocation of sugar, was very much higher in the soils giving good yields of nuts than in the poor-yielding soils (table 12). Good-yielding soils contained an average of 94.43 ppm. of potassium, whereas the poor-yielding soils had only an average of 56.1 ppm.

Like the potassium content, the calcium content of the good soils was very much higher than that of the poor soils (table 13). The amount of exchangeable calcium ranged from 2656.14 ppm. in the poor-yielding soils to 2886.75 ppm. in the good soils.

The trend of composition of magnesium was different from that of the other elements. The low-yielding soils had more magnesium than the high-yielding soils (table 14). The average amounts were 1162.61 ppm. for the low-yielding soils and 1042.91 for the high-yielding soils.

The pH. The pH value of the good- and poor-yielding soils ranged from 6.0 to 6.2 (table 15). There was no significant difference between the two types of soils.

Potash content of coconut water. The potash content of the coconut water from the high-yielding trees was higher than that from the low-yielding trees (tables 16 and 17). It will be recalled that the exchangeable potassium in the high-yielding soils was significantly higher than in the low-yielding soils. This fact might account for the difference in the potassium contents of the coconut water. Salgado (1951) reported that the potash content of the water increases with a corresponding increase in the amount of exchangeable potassium in the soil.

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TABLE 1

Sand content of good-yielding coconut soils

COMPOSITE NO.	SURFACE SOIL			COMPOSITE NO.	SUBSOIL		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
1	51.97	49.60	101.57	1	47.43	49.67	97.10
2	55.57	54.50	110.07	2	51.00	52.09	103.09
3	59.46	58.38	117.84	3	52.90	55.06	107.96
4	59.81	61.96	121.77	4	50.93	50.93	86.81
5	58.87	56.68	115.55	5	43.62	43.19	99.62
6	59.36	61.39	120.75	6	49.61	50.01	101.23
7	56.60	58.78	115.38	7	49.50	51.73	101.86
8	67.76	68.83	136.59	8	54.65	55.72	110.37
9	56.37	52.01	108.38	9	54.09	51.90	105.99
10	47.72	48.73	96.45	10	50.46	52.73	103.19
Total	573.49	570.86	1,144.35		504.19	513.03	1,017.22
Mean			57.22				50.86

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	404.06	404.06	9.52 [a]	4.41	8.28
Composites within groups	18	763.65	42.43	22.44	2.15	2.30
Determinations within composites	20	37.33	1.89			
Total	39	1,205.04				

[a] Significant.

TABLE 2

Sand content of poor-yielding coconut soils

COMPOSITE NO.	SURFACE SOIL			COMPOSITE NO.	SUBSOIL		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
11	58.21	59.11	117.32	11	57.04	54.89	111.93
12	58.82	59.53	118.35	12	57.49	55.18	112.67
13	60.39	57.82	118.21	13	58.82	62.52	121.34
14	66.01	68.19	134.20	14	61.08	58.92	120.00
15	46.02	53.36	99.38	15	50.06	46.02	96.08
16	59.00	56.80	115.80	16	54.94	57.08	112.02
17	66.63	62.35	128.98	17	59.97	58.21	118.18
18	59.66	61.53	121.19	18	57.53	59.40	116.93
19	56.26	59.49	115.75	19	53.81	59.34	113.15
20	61.72	62.79	124.51	20	56.04	54.97	111.01
Total	592.72	600.97	1,193.69		566.78	566.53	1,133.31
Mean			59.68				56.67

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	90.95	90.95	2.69 [a]	4.41	8.28
Composites within groups	18	608.33	33.79	8.55	2.15	2.30
Determinations within composites	20	79.04	3.95			
Total	39	778.32				

[a] Not significant.

TABLE 3

Clay content of good-yielding coconut soils

COMPOSITE NO.	SURFACE SOIL			COMPOSITE NO.	SUBSOIL		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
1	24.21	25.72	49.93	1	31.15	30.70	61.85
2	18.17	18.17	36.34	2	20.57	19.48	40.05
3	19.65	20.73	40.38	3	25.11	22.93	48.04
4	20.56	18.84	39.40	4	23.12	27.46	50.58
5	21.04	23.01	44.05	5	28.99	30.48	59.47
6	21.98	17.64	39.62	6	26.82	24.63	51.45
7	24.41	22.22	46.63	7	31.30	26.88	58.18
8	17.44	17.44	34.88	8	26.08	26.08	52.16
9	22.17	20.00	42.17	9	23.31	21.13	44.44
10	27.23	23.19	50.42	10	29.81	23.71	53.52
Total	216.86	206.96	423.82		266.26	253.48	519.74
Mean			21.19				25.99

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	229.51	229.51	12.75 [a]	4.41	8.28
Composites within groups	18	324.02	18.00	4.28	2.15	2.30
Determinations within composites	20	84.24	4.21			
Total	39	637.77				

L.S.M.D. = 2.82

[a] Significant.

TABLE 4

Clay content of poor-yielding coconut soils

COMPOSITE NO.	SURFACE SOIL			COMPOSITE NO.	SUBSOIL		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
11	18.34	20.54	38.88	11	24.36	24.36	48.72
12	21.84	20.70	42.54	12	22.86	24.02	46.88
13	17.12	18.05	35.17	13	21.84	19.25	41.09
14	16.32	16.32	32.64	14	24.52	24.52	49.04
15	24.78	20.32	45.10	15	25.44	27.29	52.73
16	16.17	18.38	34.55	16	20.24	18.12	38.36
17	16.02	16.02	32.04	17	18.27	18.48	36.75
18	18.12	17.59	35.71	18	18.44	20.06	38.50
19	21.09	20.00	41.09	19	23.95	20.64	44.59
20	15.37	16.17	31.54	20	21.47	24.26	45.73
Total	185.17	184.09	369.26		221.39	221.00	442.39
Mean			18.46				22.12

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	133.71	133.71	6.53 [a]	4.41	8.28
Composites within groups	18	363.20	20.18	11.33	2.15	2.30
Determinations within composites	20	35.64	1.78			
Total	39	398.84				

L.S.M.D. = 3.63

[a] Significant.

TABLE 5

Silt content of good-yielding coconut soils

COMPOSITE NO.	SURFACE SOIL			COMPOSITE NO.	SUBSOIL		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
1	23.72	24.68	48.40	1	21.42	19.63	41.05
2	26.26	27.33	53.59	2	28.43	28.43	56.86
3	20.89	20.89	41.78	3	21.99	22.00	43.99
4	19.53	19.20	38.73	4	25.95	21.61	47.56
5	20.09	20.31	40.40	5	27.39	26.73	54.12
6	18.81	20.97	39.78	6	23.57	21.36	44.93
7	18.99	19.00	37.99	7	19.20	21.39	40.59
8	14.80	13.73	28.53	8	19.27	18.20	37.47
9	21.46	27.99	49.45	9	22.60	26.97	49.57
10	25.05	28.08	53.13	10	19.73	23.56	43.29
Total	209.60	222.18	431.73		229.55	229.88	459.43
Mean			21.59				22.97

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	19.12	19.07	0.77 [a]	4.41	8.28
Composites within groups	18	447.31	24.85	10.76	2.15	2.30
Determinations within composites	20	46.26	2.31			
Total	39	512.69				

[a] Not significant.

TABLE 6

Silt content of poor-yielding coconut soils

COMPOSITE NO.	SURFACE SOIL			COMPOSITE NO.	SUBSOIL		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
11	23.45	22.35	45.80	11	18.60	20.75	39.35
12	19.34	19.77	39.11	12	19.65	20.80	40.45
13	22.49	24.13	46.62	13	19.34	18.23	37.57
14	17.67	15.49	33.16	14	14.40	16.46	30.86
15	29.20	26.32	55.52	15	24.50	26.69	51.19
16	24.83	24.82	49.65	16	24.82	24.80	49.62
17	17.35	21.63	38.98	17	21.76	23.31	45.07
18	22.22	20.88	43.10	18	24.03	20.54	44.57
19	22.64	20.51	43.15	19	22.24	20.02	42.26
20	22.91	21.04	43.95	20	22.49	20.77	43.26
Total	222.10	216.94	439.04		211.83	212.37	424.20
Mean			21.95				21.21

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	5.51	5.51	0.30 [a]	4.41	8.28
Composites within groups	18	327.20	18.18	7.67	2.15	2.30
Determinations within composites	20	47.48	2.37			
Total	39	380.19				

[a] Not significant.

TABLE 7

Water-holding capacity of good-yielding coconut soils

COMPOSITE NO.	SURFACE SOIL			COMPOSITE NO.	SUBSOIL		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
1	34.64	32.17	66.81	1	39.35	40.02	79.37
2	33.94	34.81	68.75	2	38.64	39.57	78.21
3	31.39	35.43	66.82	3	40.02	37.91	77.93
4	32.89	34.35	67.24	4	39.26	36.05	75.31
5	36.95	38.19	75.14	5	46.87	48.89	95.76
6	30.74	32.47	63.21	6	43.16	41.27	84.43
7	31.69	33.35	65.04	7	49.85	51.13	100.98
8	34.32	37.96	72.28	8	40.08	36.99	77.07
9	43.70	42.89	86.59	9	42.82	44.41	87.23
10	34.89	32.33	67.22	10	45.50	46.29	91.79
Total	345.15	353.95	699.10		425.55	422.53	848.08
Mean			34.96				42.40

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	554.87	554.87	17.81	4.41	8.28
Composites within groups	18	560.67	31.15	13.66	2.15	2.30
Determinations within composites	20	45.59	2.28			
Total	39	1,161.13				

L.S.M.D. = 3.70

[a] Significant.

TABLE 10

Total nitrogen content of good- and poor-yielding coconut soils

COMPOSITE NO.	GOOD-YIELDING SOILS			COMPOSITE NO.	POOR-YIELDING SOILS		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
1	0.15	0.14	0.29	11	0.09	0.11	0.20
2	0.14	0.12	0.26	12	0.09	0.11	0.20
3	0.11	0.11	0.22	13	0.10	0.10	0.20
4	0.12	0.12	0.24	14	0.10	0.10	0.20
5	0.15	0.17	0.32	15	0.11	0.12	0.23
6	0.17	0.15	0.32	16	0.12	0.11	0.23
7	0.12	0.11	0.23	17	0.10	0.12	0.22
8	0.17	0.15	0.32	18	0.12	0.11	0.23
9	0.13	0.10	0.23	19	0.08	0.08	0.16
10	0.14	0.16	0.30	20	0.12	0.10	0.22
Total	1.40	1.33	2.73		1.03	1.06	2.09
Mean			0.14				0.10

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	.0101	.0101	16.83 [a]	4.41	8.28
Composites within groups	18	.0101	.0006	1.20	2.15	2.30
Determinations within composites	20	.0104	.0005			

L.S.M.D. = 0.005

[a] Highly significant.

TABLE 11

Available phosphorus content of good- and poor-yielding coconut soils

COMPOSITE NO.	GOOD-YIELDING SOILS			COMPOSITE NO.	POOR-YIELDING SOILS		
	Determination		Total		Determination		Total
	I	II			I	II	
	ppm.	*ppm.*	*ppm.*		*ppm.*	*ppm.*	*ppm.*
1A	51.23	49.89	101.12	11A	35.76	34.98	70.74
2	40.38	41.32	81.70	12	33.44	35.76	69.20
3	60.73	60.73	121.46	13	34.98	35.76	70.74
4	60.73	60.73	121.46	14	35.76	35.76	71.52
5	35.78	37.04	72.82	15	38.05	38.80	76.85
6	44.35	44.35	88.70	16	26.96	26.96	53.92
7	38.66	38.66	77.32	17	30.24	28.70	58.94
8	36.28	36.28	72.56	18	26.96	26.96	53.92
9	44.35	44.35	88.70	19	34.98	34.98	69.96
10	49.89	48.63	98.52	20	26.96	26.96	53.92
Total	462.38	461.98	924.36		324.09	325.62	649.71
Mean			46.22				32.49

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	1,885.82	1,885.82	18.63 [a]	4.41	8.28
Composites within groups	18	1,882.41	101.25	266.45	2.15	2.30
Determinations within composites	20	7.69	0.38			
Total	39	3,715.92				

L.S.M.D. = 6.68

[a] Highly significant.

TABLE 10

Total nitrogen content of good- and poor-yielding coconut soils

COMPOSITE NO.	GOOD-YIELDING SOILS			COMPOSITE NO.	POOR-YIELDING SOILS		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
1	0.15	0.14	0.29	11	0.09	0.11	0.20
2	0.14	0.12	0.26	12	0.09	0.11	0.20
3	0.11	0.11	0.22	13	0.10	0.10	0.20
4	0.12	0.12	0.24	14	0.10	0.10	0.20
5	0.15	0.17	0.32	15	0.11	0.12	0.23
6	0.17	0.15	0.32	16	0.12	0.11	0.23
7	0.12	0.11	0.23	17	0.10	0.12	0.22
8	0.17	0.15	0.32	18	0.12	0.11	0.23
9	0.13	0.10	0.23	19	0.08	0.08	0.16
10	0.14	0.16	0.30	20	0.12	0.10	0.22
Total	1.40	1.33	2.73		1.03	1.06	2.09
Mean			0.14				0.10

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	.0101	.0101	16.83 [a]	4.41	8.28
Composites within groups	18	.0101	.0006	1.20	2.15	2.30
Determinations within composites	20	.0104	.0005			

L.S.M.D. = 0.005

[a] Highly significant.

TABLE 11

Available phosphorus content of good- and poor-yielding coconut soils

COMPOSITE NO.	GOOD-YIELDING SOILS			COMPOSITE NO.	POOR-YIELDING SOILS		
	Determination		Total		Determination		Total
	I	II			I	II	
	ppm.	*ppm.*	*ppm.*		*ppm.*	*ppm.*	*ppm.*
1A	51.23	49.89	101.12	11A	35.76	34.98	70.74
2	40.38	41.32	81.70	12	33.44	35.76	69.20
3	60.73	60.73	121.46	13	34.98	35.76	70.74
4	60.73	60.73	121.46	14	35.76	35.76	71.52
5	35.78	37.04	72.82	15	38.05	38.80	76.85
6	44.35	44.35	88.70	16	26.96	26.96	53.92
7	38.66	38.66	77.32	17	30.24	28.70	58.94
8	36.28	36.28	72.56	18	26.96	26.96	53.92
9	44.35	44.35	88.70	19	34.98	34.98	69.96
10	49.89	48.63	98.52	20	26.96	26.96	53.92
Total	462.38	461.98	924.36		324.09	325.62	649.71
Mean			46.22				32.49

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	1,885.82	1,885.82	18.63 [a]	4.41	8.28
Composites within groups	18	1,882.41	101.25	266.45	2.15	2.30
Determinations within composites	20	7.69	0.38			
Total	39	3,715.92				

L.S.M.D. = 6.68

[a] Highly significant.

TABLE 12

Potassium content of good- and poor-yielding coconut soils

COMPOSITE NO.	GOOD-YIELDING SOILS			COMPOSITE NO.	POOR-YIELDING SOILS		
	Determination		Total		Determination		Total
	I	II			I	II	
	ppm.	*ppm.*	*ppm.*		*ppm.*	*ppm.*	*ppm.*
1	94.49	93.00	187.49	11	58.51	57.00	115.51
2	97.51	97.51	195.02	12	58.51	58.51	117.02
3	97.51	97.51	195.02	13	49.51	49.51	99.02
4	97.51	97.51	195.02	14	51.00	51.00	102.00
5	94.49	94.49	188.98	15	57.00	55.51	112.51
6	94.49	93.00	187.49	16	55.51	57.00	112.51
7	90.00	90.00	180.00	17	60.00	58.51	118.51
8	93.00	93.00	186.00	18	57.00	55.51	112.51
9	90.00	90.00	180.00	19	55.51	57.10	112.61
10	97.51	96.00	193.51	20	60.00	60.00	120.00
Total	946.51	942.02	1,888.53		562.55	559.65	1,122.20
Mean			94.43				56.11

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	14,681.54	14,681.54	736.66 [a]	4.41	8.28
Composites within groups	18	358.73	19.93	39.07	2.15	2.30
Determinations within composites	20	10.20	0.51			
Total	39	15,050.47				

L.S.M.D. = 2.96

[a] Highly significant.

TABLE 13

Calcium content of good- and poor-yielding coconut soils

COMPOSITE NO.	GOOD-YIELDING SOILS			COMPOSITE NO.	POOR-YIELDING SOILS		
	Determination		Total		Determination		Total
	I	II			I	II	
	ppm.	*ppm.*	*ppm.*		*ppm.*	*ppm.*	*ppm.*
1	2947.00	2947.00	5894.00	11	2726.08	2726.08	5452.16
2	3020.92	3020.42	6041.34	12	2726.08	2726.08	5452.16
3	3315.76	3315.76	6631.52	13	3020.92	3020.92	6041.84
4	3315.76	3315.76	6631.52	14	3020.92	3020.92	6041.84
5	3094.56	3168.20	6262.76	15	2947.00	2873.64	5820.64
6	3094.56	3168.20	6262.76	16	2873.64	2947.00	5820.64
7	3020.92	3094.56	6115.48	17	2357.88	2283.96	4641.84
8	3094.56	3168.20	6262.76	18	2283.96	2283.96	4567.92
9	1311.52	2504.88	3816.40	19	2283.96	2357.88	4641.84
10	1311.52	2504.88	3816.40	20	2283.96	2357.88	4641.84
Total	27527.08	30207.86	57734.94		26524.40	26598.32	53122.72
Mean			2886.75				2656.14

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	531,814.33	531,814.33	5.43 [a]	4.41	8.28
Composites within groups	18	1,761,524.69	97,862.48	3.41	2.15	2.30
Determinations within composites	20	573,442.02	28,672.10			
Total	39	8,766,781.04				

L.S.M.D. = 207.83

[a] Significant.

TABLE 14

Magnesium content of good- and poor-yielding coconut soils

COMPOSITE NO.	GOOD-YIELDING SOILS			COMPOSITE NO.	POOR-YIELDING SOILS		
	Determination		Total		Determination		Total
	I	II			I	II	
	ppm.	*ppm.*	*ppm.*		*ppm.*	*ppm.*	*ppm.*
1	1014.92	1021.90	2036.82	11	1212.13	1212.13	2424.26
2	917.32	917.32	1934.64	12	1179.26	1179.26	2358.52
3	949.69	956.66	1906.35	13	1205.66	1212.13	2417.79
4	1245.00	1245.00	2490.00	14	1245.00	1245.00	2490.00
5	1113.53	1113.53	2227.06	15	1245.00	1245.00	2490.00
6	1021.90	1021.90	2043.09	16	1146.40	1146.40	2292.80
7	1008.95	1014.92	2023.87	17	1048.29	1048.29	2096.58
8	949.69	956.66	1906.35	18	1245.00	1245.00	2490.00
9	1048.89	1048.29	2097.18	19	1048.29	1048.29	2096.58
10	1146.40	1146.40	2292.80	20	1048.29	1048.29	2096.58
Total	10416.29	10441.87	20858.16		11623.32	11629.79	23253.11
Mean			1042.91				1162.66

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	143,394.63	143,394.63	8.32 [a]	4.41	8.28
Composites within groups	18	310,329.55	17,240.53	24.21	2.15	2.30
Determinations within composites	20	142.55	7.12			

L.S.M.D. = 87.49

[a] Significant.

TABLE 15

The pH value of good- and poor-yielding coconut soils

COMPOSITE NO.	GOOD-YIELDING SOILS			COMPOSITE NO.	POOR-YIELDING SOILS		
	Determination		Total		Determination		Total
	I	II			I	II	
	per cent	*per cent*	*per cent*		*per cent*	*per cent*	*per cent*
1	6.1	6.0	12.1	11	6.0	6.0	12.0
2	6.0	6.0	12.0	12	6.0	6.0	12.0
3	6.2	6.2	12.4	13	6.0	6.0	12.0
4	6.0	6.0	12.0	14	6.2	6.2	12.4
5	6.1	6.1	12.2	15	6.2	6.1	12.3
6	6.2	6.1	12.3	16	6.1	6.1	12.2
7	6.1	6.2	12.3	17	6.2	6.2	12.4
8	6.2	6.2	12.4	18	6.1	6.1	12.2
9	6.2	6.2	12.4	19	6.0	6.2	12.2
10	6.1	6.1	12.2	20	6.1	6.1	12.2
Total	61.2	61.1	122.3		60.9	61.0	121.9
Mean			6.12				6.10

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	VARIANCE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Groups	1	0.00	0.0000	0.00 [a]	4.41	8.28
Composites within groups	18	0.23	0.0128	8.53	2.15	2.30
Determinations within composites	20	0.03	0.0015			

[a] Not significant.

TABLE 16

Potash content of coconut water in trial I

SAMPLE NO.	WEIGHT OF POTASH IN COCONUT WATER FROM GOOD-YIELDING TREES	WEIGHT OF POTASH IN COCONUT WATER FROM POOR-YIELDING TREES
	grams per liter	*grams per liter*
1	.6294	.5440
2	.6588	.5568
3	.6700	.4816
4	.6725	.5548
5	.6382	.5384
6	.6518	.5592
7	.6636	.5326
8	.6588	.5070
9	.6712	.5668
10	.9982	.5188
Total	6.5930	5.3600
Mean	.66	.54

Mean difference = 0.1233
Standard error of difference = .0092
Computed t = 13.39
Probability < .01

TABLE 17

Potash content of coconut water in trial II

SAMPLE NO.	WEIGHT OF POTASH IN COCONUT WATER FROM GOOD-YIELDING TREES	WEIGHT OF POTASH IN COCONUT WATER FROM POOR-YIELDING TREES
	grams per liter	*grams per liter*
1	.6464	.5364
2	.6588	.5680
3	.6720	.4988
4	.6750	.5528
5	.6380	.5520
6	.6590	.5462
7	.6626	.5340
8	.6506	.5316
9	.6698	.5674
10	.6710	.5208
Total	6.6032	5.4080
Mean	.66	.54

Mean difference = 0.1195
Standard error of the difference = .0081
Computed t = 14.75
Probability < .01

THE AGRONOMIC CHARACTERS OF TEN VARIETIES OF KENAF[1]

HERMINIO A. ALCANITES

WITH THREE TEXT FIGURES

None of the 10 kenaf varieties may be classified as branching types; the branches that appeared later were due to insect attacks. The varieties differed significantly in tensile strength. Salvador Selection gave the highest mean tensile strength of 24.80 kilometers. The fibers weighing from 0.5 to 0.7 milligram had higher tensile strength than those weighing from 0.2 to 0.4 milligram. *Simplex* produced the most fiber of 85.3 grams for every 10 plants, followed by Salvador Selection, which produced 70 grams. The other varieties were far below in yield.

On the basis of high fiber yield *Simplex*, Salvador Selection, and *vulgaris* may be recommended; on the basis of tensile strength, however, Salvador Selection, Maceo, and Cubano may be recommended.

Since its introduction in 1947 in the College of Agriculture, kenaf (*Hibiscus cannabinus* Linn.) has revitalized the fiber industry in the Philippines. It is not only easy to grow, but it also yields comparatively more fiber than jute. It is timely, therefore, to study the agronomic characters of some promising red-stemmed and green-stemmed varieties of kenaf to gather information which may be of help to local farmers in their selection of which variety and strain to plant.

MATERIALS AND METHODS

Preparation of the land. A fairly well-drained field of clay loam soil which had previously been planted to jute was plowed twice with a tractor. Pulverizing and furrowing were done mainly by hand. The field was divided into three blocks of 10 square meters each with half-meter paths between the blocks. Each block was divided into 1 square-meter plots. The complete randomized block experimental design was adopted.

Seed treatment. The seeds of Cubano (CA 766), Cuba 797 (CA 667), and Maceo (CA 768) were obtained from Cuba; those of Tingo Maria (CA 769), Java (CA 770), Salvador Selection (CA 771), Formosa Selection (CA 772), *viridis* (CA 777), and *vulgaris* (CA 778), from A. Soriano y Cia; and those of *simplex* (CA 779), from the Department of Agronomy. They were soaked separately for five minutes in 1:1000 mercuric bichloride before planting.

[1] Central Experiment Sattion Contribution No. 1786. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Agronomy under the direction of Associate Professor Pedro A. David and Instructor Jose R. Mondoñedo.

Planting. On May 21, 1953, the seeds were planted by hand in three replications, with every variety occupying an area of 1 square meter. Planting distances were 12 inches between rows and 2 inches between hills. In a 1-square-meter plot there were three rows, each composed of 18 hills. Variety *simplex* was replanted five days after planting because of its very low percentage of germination.

As soon as the plants had reached the height of 8 to 10 inches, they were thinned so that the distances would be 2 inches between rows and 12 inches between hills.

Weeding and cultivation. Weeding and cultivation of all plots were done at the same time, two weeks after planting. Afterwards weeding was unnecessary because the leaves of the plants covered practically all of the ground surface, thus preventing the growth of weeds. Cultivation, however, was done up to the third week.

Measurement of the plants. Weekly measurements of the height of 10 plants of every variety in each block were recorded up to maturity. The height of flowering nodes was also measured, and the number of capsules was counted when the plants were harvested.

Harvesting. Because of the difference in maturity periods of the varieties, the plots were not harvested at the same time. The plants were cut very close to the ground and tied in bundles for weighing and retting.

The harvested plants were stripped into ribbons. Then they were retted in a cement tank with a continuous outflow of water. On the tenth day, the ribbons were washed, hung, and allowed to dry.

The plants for the seed production test were harvested as soon as the leaves had been shed and the capsules had matured. Selected plants were carefully cut just below the first capsule. The capsules were threshed and the seeds were winnowed and weighed.

Determination of tensile strength. A Scott Tester IP-2 Tensilgraph machine was used to determine the breaking load of samples of single-fiber strands taken from the different varieties. The tensile strength expressed in breaking length was then computed according to the following formula of Botkin, Shires, and Smith:[2]

$$\text{Tensile strength expressed in breaking length} = \frac{\text{Breaking load}}{\text{Weight of samples per centimeter}}$$

RESULTS AND DISCUSSION

Pests and diseases. To prevent damage by *Nisotra gemella* Erichson, *Dysdercus megalopygus* Breddin, and *Dysdercus poecilius* Herrich Schaffer,[3] Gesarol 50 was to have been sprayed on the

[2] C. W. Botkin, C. B. Shires, and E. C. Smith, *New Mexico Agric. Exper. Sta. Bull.*, 300 (1943).

[3] All the insects mentioned in this paper were identified by Dr. Silverio M. Cendaña, Department of Entomology.

Fig. 1.—Effect of root knot on the plants. (*Photographed by the Photographic Division.*)

plants 5 times at intervals of 10 to 15 days. This prescribed treatment, however, was not followed because of unfavorable weather. The insects, especially *Nisotra gemella* Erichson, bored holes into the leaves.

A fungus disease caused by a species of Phoma, probably *Phoma sabdariffae* Sacc.,[4] stunted the growth of the plants and disturbed the vegetation. Gycop 53 was used to combat the fungus. Another disease noted was root knot, *Heterodera radicicola* (Greef) Muller (fig. 1). This disease can not be controlled by spraying; the main protection against it is disinfection of the soil before the seeds are planted.

The attacks of pests and diseases prevented the plants from attaining maximum height, yield of fiber, and number of seed capsules.

Characteristics of the different varieties. Table 1 presents the characteristics of the 10 varieties studied. The shapes of the leaves are shown in figure 2.

Fig. 2.—Shapes of different varieties of kenaf: (1) Salvador Selection (CA 771), (2) *simplex* (CA 779), (3) Cubano (CA 766), (4) Cuba 797 (CA 797), (5) Java (CA 770), (6) Maceo (CA 768), (7) Tingo Maria (CA 769), (8) *viridis* (CA 777), (9) Formosa Selection (CA 772), (10) *vulgaris* (CA 778). (*Photographed by the Photographic Division.*)

Height of flowering nodes. Salvador Selection gave the highest mean height of flowering node (table 2. It had a significantly

[4] Dr. F. T. Orillo of the Department of Plant Pathology identified the diseases.

higher flowering node than Tingo Maria, Java, Formosa Selection, Cuba 797, *vulgaris*, and *simplex*. Maceo, Cubano, *viridis*, Tingo Maria, and Java had significantly higher flowering nodes than *simplex*.

Height of plants at maturity. At maturity Salvador Selection was taller than Cubano, Tingo Maria, Java, Formosa Selection, *viridis*, Cuba 797, and *vulgaris*, whereas Maceo and Cubano were taller than *vulgaris* (table 3).

Amount of fiber. The differences in the mean yields of dry fiber of the varieties (fig. 3) were highly significant. As shown in table 4, *simplex* outyielded the other varieties.

It may be noted in tables 3 and 4 that taller plants do not necessarily yield more fiber than the shorter ones. Salvador Selection is taller than *simplex*, but *simplex* gives more fiber. This may be because the stems of *simplex* are big, even if they are a little shorter, whereas those of Salvador Selection are long and very slender. Big stems yield more fiber than slender ones.

Tensile strength. Salvador Selection gave the highest mean tensile strength among all the varieties (table 5). It was noted that fibers weighing 0.5 to 0.7 milligram had higher tensile strength than those weighing 0.2 to 0.4 milligram. Varieties with high tensile strength were observed to have fibers with bigger strands than those with low tensile strength.

Number of capsules. The varieties showed highly significant differences in number of capsules (table 6). Maceo gave the highest mean number of capsules. Tingo Maria and Formosa Selection were not included in the computation because they did not bear capsules. The two varieties flowered, but their flowers fell off after two days. This could have been due to the wind and to insect attacks.

Length of growth period. The plants were harvested when more than 50 per cent of them were at the blooming stage. *Vulgaris* and Cubano had a growth period of 120 days; Salvador Selection, Cuba 797, Maceo, Tingo Maria, and *viridis*, 121 days; Java, 123 days; Formosa Selection, 124 days; and *simplex*, 132 days.

Length of capsule development. The period of capsule development refers to the time when more than 50 per cent of the plants in the plots are flowering up to the time when more than 50 per cent of the plants in the plots have mature capsules. *Viridis* had the shortest period of development, 71 days. Cuba 797 and Salvador Selection completed capsule development in 80 days, Cubano in 82 days, *simplex* in 86 days, Maceo in 87 days, *vulgaris* in 88 days, and Java in 89 days.

Branching. None of the 10 varieties may be classified as branching types. The branches that appeared later were due to the insect attacks. After the insects had cut the top portion of the plants, branching followed immediately. Plants that were not attacked by insects did not produce branches.

Fig. 3.—Fibers of the varieties: (1) Salvador Selection (CA 771), (2) *simplex* (CA 779), (3) Cubano (CA 766), (4) Cuba 797 (CA 797), (5) Java (CA 770), (6) Maceo (CA 768), (7) Tingo Maria (CA 769), (8) *viridis* (CA 777), (9) Formosa Selection (CA 772), (10) *vulgaris* (CA 778). (*Photographed by the Photographic Division.*)

TABLE 1

Characteristics of the different varieties

VARIETY	SHAPE OF LEAVES	COLOR OF STEM	NATURE OF STEM	SUSCEPTIBILITY TO PESTS	SUSCEPTIBILITY TO DISEASES
Salvador Selection (CA 771)	Entire	Green	Spiny	Fairly susceptible	Susceptible
Simplex (CA 779)	Entire	Green with tan striping at basal portion	Fairly spiny	Fairly susceptible	Susceptible
Cubano (CA 776)		Green	Fairly spiny	Fairly susceptible	Susceptible
Cuba 797 (CA 797)	Entire	Bright green	Smooth	Fairly susceptible	Susceptible
Java (CA 770)	Divided	Dark purple	Spiny	Fairly susceptible	Susceptible
Maceo (CA 768)	Entire	Red to amber with green tip	Smooth	Fairly susceptible	Susceptible
					Susceptible
Tingo Maria (CA 769) ...	Entire	Dark purple	Fair	Highly susceptible	Susceptible
Viridis (CA 777)	Entire	Green	Fair	Fairly susceptible	Susceptible
Formosa Selection (CA 772)	Divided	Reddish purple	Fair	Fairly susceptible	
Vulgaris (CA 778)	Divided	Green	Fair	Fairly susceptible	Susceptible

TABLE 2

Height of flowering nodes in centimeters

VARIETY	REPLICATION			TOTAL	MEAN
	1	2	3		
Salvador Selection (CA 771)	156.6	163.0	153.4	473.0	157.67
Simplex (CA 779)	135.2	117.4	112.8	365.4	121.80
Cubano (CA 766)	160.5	150.4	122.5	433.4	144.47
Cuba 797 (CA 797)	143.0	129.5	130.1	402.6	134.2
Java (CA 770)	131.7	154.6	135.3	421.6	140.53
Maceo (CA 768)	142.5	141.6	149.5	433.6	144.53
Tingo Maria (CA 769)	141.3	144.5	136.5	422.3	140.77
Viridis (CA 777)	145.1	148.4	137.6	431.1	143.70
Formosa Selection (CA 772)	141.2	143.0	135.6	419.8	139.93
Vulgaris (CA 778)	144.7	126.5	140.2	411.4	137.13
Total	1,441.8	1,418.9	1,353.5	4,214.2	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					0.05	0.01
Between blocks	2	419.95	209.98	2.62		
Between varieties	9	2,214.11	246.01	3.07	2.46	3.10
Error	18	1,442.80	80.16			
Total	29	4,076.86				

L.S.M.D. = 15.34

TABLE 3

Height of plants at maturity in centimeters

VARIETY	REPLICATION			TOTAL	MEAN
	1	2	3		
Salvador Selection (CA 771)	200.5	210.5	208.0	619.0	206.33
Simplex (CA 779)	212.6	191.0	191.0	594.6	198.2
Cubano (CA 766)	195.6	193.6	174.0	563.2	187.73
Cuba 797 (CA 797)	177.6	180.1	185.5	543.2	181.07
Java (CA 770)	191.2	168.8	191.6	549.5	183.17
Maceo (CA 768)	199.1	188.0	196.5	583.6	194.53
Tingo Maria (CA 769)	178.8	192.0	180.5	551.3	183.77
Viridis (CA 777)	170.5	185.2	182.3	537.9	179.30
Formosa Selection (CA 772)	178.5	186.4	182.5	547.4	182.47
Vulgaris (CA 778)	183.9	171.2	173.5	528.6	176.2
Total	1,888.3	1,864.8	1,865.2	5,618.3	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					0.05	0.01
Between blocks	2	36.20	18.10	.22		
Between varieties	9	2,437.73	270.86	3.334	2.46	3.60
Error	18	1,462.34	21.24			
Total	29	3,936.27				

L.S.M.D. = 15.44

TABLE 4

Yield of dry fiber in grams

VARIETY	REPLICATION			TOTAL	MEAN
	1	2	3		
Salvador Selection (CA 771)..	54.0	75.5	81.0	210	70.0
Simplex (CA 779)	88.0	92.0	76.0	256	85.3
Cubano (CA 766)	52.5	51.0	53.0	156.5	52.2
Cuba 797 (CA 797)	43.0	41.0	38.0	122	40.7
Java (CA 770)	37.0	25.5	28.0	90.5	30.2
Maceo (CA 768)	46.0	58.0	61.0	165	55.0
Tingo Maria (CA 769)	48.0	57.0	48.0	153	51.0
Viridis (CA 777)	58.0	62.0	53.0	173	57.7
Formosa Selection (CA 772)..	30.5	33.1	27.0	90.6	30.2
Vulgaris (CA 778)	67.0	62.0	58.0	187.0	62.3
Total	524.0	556.6	523.0	1,603.6	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					0.05	0.01
Between blocks .	2	73.09	36.55	.79		
Between varieties	9	7,929.85	881.09	18.98	2.46	3.60
Error	18	835.65	46.43			
Total	29	8,838.59				

L.S.M.D. = 11.68

TABLE 5

Tensile strength of fiber in kilometers

VARIETY	REPLICATION			TOTAL	MEAN
	1	2	3		
Salvador Selection (CA 771) ..	22.16	27.89	24.36	74.41	24.80
Simplex (CA 779)	24.19	20.20	21.67	66.06	22.02
Cubano (CA 766)	25.11	21.67	21.67	68.45	22.8
Cuba 797 (CA 797)	14.31	15.31	16.05	45.67	15.2
Java (CA 770)	19.59	17.49	25.62	62.70	20.9
Maceo (CA 768)	25.21	26.48	19.11	70.80	23.6
Tingo Maria (CA 769)	17.47	17.09	17.59	52.15	17.4
Viridis (CA 777)	20.57	17.18	23.35	61.10	20.4
Formosa Selection (CA 772) ..	18.85	20.99	21.04	60.88	20.3
Vulgaris (CA 778)	18.13	28.21	21.89	68.23	22.7
Total	205.59	212.51	212.35	630.45	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					0.05	0.01
Between blocks .	2	3.12	1.55	.16		
Between varieties	9	227.89	25.32	2.65	2.46	3.60
Error	18	172.07	9.56			
Total	29	403.08				

L.S.M.D. = 5.30

TABLE 6

Number of capsules

VARIETY	REPLICATION			TOTAL	MEAN
	1	2	3		
Salvador Selection (CA 771)	3.4	4.0	5.2	12.6	4.2
Simplex (CA 779)	5.8	6.6	6.3	18.7	6.2
Cubano (CA 766)	5.6	6.2	5.6	17.4	5.8
Cuba 797 (CA 797)	6.8	5.8	5.4	18.00	6.0
Java (CA 770)	3.8	3.6	3.6	11.0	3.6
Maceo (CA 768)	6.2	6.4	6.8	19.4	6.5
Viridis (CA 777)	5.2	5.8	5.8	16.8	5.6
Vulgaris (CA 778)	5.2	5.8	5.4	16.4	5.5
Total	42.0	44.2	44.1	130.3	

Analysis of variance

SOURCE OF VARIATION	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					0.05	0.01
Between blocks	2	138	.19	.95		
Between varieties	9	20.50	2.28	11.40	2.46	3.60
Error	18	3.54	.20			
Total	79	24.43				

L.S.M.D. = .77

THE EFFECTS OF THERMOPHOS AND HYPERPHOSPHATE FERTILIZERS APPLIED TO LIPA CLAY LOAM WITH CORN AS INDICATOR [1]

LORETO B. BUCASAS

WITH ONE TEXT FIGURE

Eight days after the application of the fertilizers, the nitrogen-treated lots had darker and broader leaves than the control and the other treated lots. The phosphatic fertilizers in the form of thermophos, superphosphate, or hyperphosphate failed to improve the vegetative growth of the corn plants and the yield of stover. Lots treated with superphosphate, hyperphosphate, and thermophos in combination with ammonium sulfate showed increases in yield which compared favorably with that of the lot treated with ammonium phosphate. Hyperphosphate, superphosphate, or thermophos alone did not change the pH value of the soil but when combined with ammonium sulfate, each reduced the pH value as well as the amount of potassium in the soil. The application of hyperphosphate, superphosphate, and thermophos alone or in combination with ammonium sulfate and of ammonium phosphate alone did not affect the water-holding capacity, rolling-out limit, sticky point, organic-matter content, and amounts of available calcium and magnesium in the soil. Of the phosphatic fertilizers used, only thermophos did not increase the available P_2O_5 in the soil.

The maintenance in the soil of an available supply of phosphorus sufficient for normal plant growth is one of the most difficult problems of soil management. Ever since fertilizer was produced on a commercial scale, ammonium phosphate and superphosphate have been the principal phosphatic fertilizers in use, even after the introduction of certain mechanical improvements. The popularity of concentrated phosphatic fertilizer is due to its qualities of minimizing the loss of plant nutrients and supplying an adequate amount of available phosphorus for a relatively long time.

Hyperphosphate and thermophos, which possess the aforementioned qualities, are theoretically ideal fertilizers. Hyperphosphate is obtained by mechanically pulverizing to a high degree a special type of sedimentary North African phosphate rock chosen for its softness and its high solubility in weak acids. Thermophos is produced by thermal processes and the resultant product, under proper control, is characterized by a low solubility. If these two substances are compatible when mixed with other fertilizers and retain the property of dissolving slowly when incorporated in the soil, the loss of phosphorus by fixation to unavailable form, which is a characteristic of soluble phosphates, would be appreciably diminished. Before

[1] Central Experiment Station Contribution No. 1787. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1954. Prepared in the Department of Soils under the direction of Dr. Nicolas L. Galvez.

thermophos and hyperphosphate can be recommended for local use, however, their performance should be compared with that of ammonium sulfate and superphosphate, which are now properly used. The present study was therefore conducted to determine the effects of thermophos and hyperphosphate, added singly or in combination with ammonium sulfate, on Lipa clay loam with corn as indicator. The experiments took place in the Department of Soils from April, 1953, to February, 1954.

Klemme [2] stated that in strongly acidic soil, phosphorus release to plants is less than in soils only slightly acidic or under neutral in reaction. A poorly drained and, hence, poorly aerated soil retards the activity of microorganisms which ordinarily help release the phosphorus from organic matter in the soil. The presence of relatively high calcium increases the pH value and amount of available phosphate in the soil.

Macasaet (1936) found that the addition of superphosphate alone to tuff soil or subsoil of Lipa clay loam was harmful to plants. The addition of a mixture of superphosphate and ammonium sulfate to tuff soil was less beneficial to rice than the addition of ammonium sulfate alone.

Minami (1950) reported that the yield and the available phosphorus of hyperphosphate-treated lots were similar to those of superphosphate-treated lots.

Corpus [3] reported that soil containing less than 1 ppm. of soluble phosphorus needs phosphatic fertilizers, but he did not recommend a continuous supply of 2½ to 5 ppm. of available phosphorus.

In Pennsylvania State College, Noll [4] found that phosphatic fertilizer shortened the period of maturity of grains in dry years, although it also caused premature ripening and a decrease in yield. Noll further noted that a rate of application of the phosphatic fertilizer above the need of the crop failed to hasten maturity.

Talamisan (1938) found that the application of superphosphate in combination with ammonium sulfate to Lipa clay loam increased the yield of grains and of tops, but only very slightly as to be negligible.

MATERIALS AND METHODS

Fertilizers. In addition to superphosphate and ammonium phosphate, thermophos and hyperphosphate were used as phosphorus carriers. Ammonium sulfate was employed as a source of nitrogen. The nitrogen content of the ammonium sulfate was 20 per cent, and that of the ammonium phosphate was 15.69 per cent. The P_2O_5 content

[2] A. W. Klemme, *Missouri Agric. Exper. Sta. Cir.*, 399 (1941).

[3] Igmidio T. Corpus, "The Applicability of Rapid Microchemical Methods in Determining Soil Fertility of Lipa Clay." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1953. Unpublished.)

[4] B. Noll, *Pennsylvania Agric. Exper. Sta. Cir.*, 126 (1920).

of superphosphate was 20.89 per cent; of ammonium phosphate, 19.69 per cent; of thermophos, 17.59 per cent; and of hyperphosphate, 26.86 per cent. The pH value of superphosphate was 2.62; of hyperphosphate, 7.78; of ammonium phosphate, 4.10; of thermophos, 8.57; and of ammonium sulfate, 4.10.

Pots. Thirty-two earthen pots each 28 cm. in diameter and 34 cm. in height and with a soil capacity of 20 kg. were used. Each pot had three 1-cm. side holes just above the bottom for drainage.

Soil. Lipa clay loam from the corn field of the Central Experiment Station was used. The surface soil was light brown in color. It was sticky when wet and easily pulverized when dry. Physical analysis showed its contents to be 21.16 per cent clay; 28.30 per cent silt; and 50.54 per cent sand. The water-holding capacity was 38.98 per cent; organic-matter content, 2.43 per cent; and pH value, 5.83. Its chemical make-up was 0.41 per cent CaO, 0.82 per cent MgO, 0.82 per cent K_2O, and 0.13 per cent P_2O_5 in reserve. The total nitrogen content was 0.12 per cent.

Preparation of the cultures. About 2.5 cm. of sand that had been retained by a 2-mm. sieve was placed in each of the pots. Lipa clay loam soil that had passed through a 10-mm. sieve was added at the rate of 18 kg. to a pot. The pots were grouped at random into eight lots of four replications each and allowed to stand for eight days.

Experimental plan. The working plan was as follows:

Lot I —Surface soil alone.
Lot II —Surface soil treated at the rate of 5.664 grams of thermophos to a pot, equivalent to 149.920 kg. of phosphoric acid to a hectare.
Lot III —Surface soil treated with hyperphosphate at the rate of 3.776 grams to a pot, equivalent to 149.920 kg. of phosphoric acid to a hectare.
Lot IV —Surface soil treated with superphosphate at the rate of 4.900 grams to a pot, equivalent to 149.920 kg. of phosphoric acid to a hectare.
Lot V —Surface soil treated with ammonium phosphate at the rate of 5.664 grams to a pot, equivalent to 149.920 kg. of phosphoric acid and 120.000 kg. of nitrogen to a hectare.
Lot VI —Surface soil treated with thermophos at the rate of 5.664 grams and ammonium sulfate at the rate of 3.980 grams, equivalent to 149.920 kg. of phosphoric acid and 120.000 kg. of nitrogen to a hectare, respectively.
Lot VII —Surface soil treated with hyperphosphate at the rate of 3.776 grams to a pot and ammonium sulfate at the rate of 3.980 grams, equivalent to 149.920 kg. of phosphoric acid and 120.000 kg. of nitrogen to a hectare, respectively.
Lot VIII—Surface soil treated with 4.9000 grams of superphosphate and 3.980 grams of ammonium sulfate, equivalent to 149.920 kg. of phosphoric acid and 120.000 kg. of nitrogen to a hectare, respectively.

Analysis of the physical properties of the soil. The method recommended by Piper (1947) was followed in determining the textural

grade, water-holding capacity, rolling-out limit, and sticky point of the soil.

Analysis of the chemical properties of the soil. The reserve plant food dissolved in 10 per cent hydrochloric acid was determined in accordance with the method described by the Commission of the International Society of Soil Science as modified by Blank and Reiser (1928), and the organic matter was determined by the method described by Peech, Dean, and Reed.[5] The pH value of the soil in water suspension was calculated according to the method described by Peech and English (1944) ; the total nitrogen content of the soil, by the Kjeldahl distillation method described by the Association of Official Agricultural Chemists (1950), modified for small amounts of sample; the available phosphorus in the soil, by the method described by Troug (1930) ; the available potassium and calcium of the soil, by the methods of Wolf and Ichisaka (1947) ; and the available magnesium, by the method of Peech and English (1944).

Planting. On May 28, 1953, selected seeds of Cuban Yellow Flint corn from the Department of Agronomy were planted at the rate of two seeds to a pot. Immediately after planting, one-fourth of the total amount of fertilizers for each treatment was applied to the surface of the soil. The remaining three-fourths was added thrice in equal portions during the growing period of the corn plants. The first was applied four weeks after planting; the second and the third were applied at intervals of two weeks.

Care and observation. During the entire growing period of the corn plants, the pots were kept clean. Watering was done when necessary. The plants were observed every other day.

Harvesting. At the age of three months and two days the plants were cut as close as possible to the ground. Their heights were measured from the base of the plant to the tip of the tassel. The stover was chopped and weighed, oven-dried, and weighed again. The ears were dried, and the kernels separated from the cob were oven-dried and weighed.

RESULTS AND DISCUSSION

Appearance of the corn plants. Effects of the fertilizers were noticed eight days after the second application. The plants in the nitrogen-treated pots were taller and had darker and broader leaves than those in the other cultures. On the other hand, hardly any difference was noted between the control and the other treated lots, which appeared chlorotic and stunted. The same results were observed by Soriano (1934), Almeda (1937), Talamisan (1938), Galvez and Bueno (1951), and Lopez.[6]

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[5] Michael Peech, L. T. Alexander, L. A. Dean, and J. Fielding Reed, *USDA Cir.*, 757 (April, 1947).

[6] Marciano M. Lopez, "Effects of Fertilizing Elements Added Singly and in Combination to Lipa Clay, Lowland Soil, with Rice as Indicator." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1953. Unpublished.)

Ten days after the second application, the plants in the nitrogen-treated pots became slightly yellowish and growth was slowed down. This result corroborates the observation of Lopez.[7]

Seven days after the third application of fertilizer, the plants in the nitrogen-treated lots resumed their former dark-green color and rapid rate of growth. The plants in the control and the other treated pots remained chlorotic; hardly any growth was noticeable. The same behavior was exhibited by the plants in the nitrogen-treated, control, and other treated pots before and after the fourth application.

Presence of pests. The presence on the plants of corn borer, *Pyrausta nubilalis* Hübner, during the flowering stage did not adversely affect the growth of the plants. The larvae of the pest were removed from the plants and killed. No corn diseases were noted during the experiment.

Height of plants. Lot VI, to which thermophos and ammonium sulfate had been added, had the tallest plants (table 1 and fig. 1). Lot II, treated with thermophos alone, had the shortest. The heights of the plants grown in lots I, II, III, and IV were statistically the same, indicating that thermophos, hyperphosphate, and su-

Fig. 1.—Comparative stand of the corn plants in the different media after 66 days: lot I contains soil alone; lot II, soil plus thermophos; lot III, soil plus hyperphosphate; lot IV, soil plus superphosphate; lot V, soil plus ammonium phosphate; lot VI, soil plus thermophos and ammonium sulfate; lot VII, soil plus hyperphosphate and ammonium sulfate; lot VIII, soil plus superphosphate and ammonium sulfate.

[7] *Ibid.*

perphosphate did not have any influence on height. It will be noted, however, that the height of the plants in lot IV was significantly greater than that of lot II, showing that superphosphate increased the height more than did thermophos.

The results show that the application of nitrogen to Lipa clay loam in the form of either ammonium sulfate or ammonium phosphate promoted the growth of the corn plants and that superphosphate, hyperphosphate, or thermophos alone was not necessary for plant growth (table 1). These findings coincide with those of Macasaet (1936), Enrile (1938), Cabotaje (1941), and Lopez.[8]

Yield of stover. The yields of stover in the nitrogen-treated pots compared favorably with those of the control and the other treated pots (table 2). The control and the lots treated with superphosphate, thermophos, and hyperphosphate alone had statistically the same yields. Likewise, the nitrogen-treated lots had statistically the same yields.

Weight of grain. The control and the lots treated with phosphatic fertilizer alone did not bear ears. The grain yields of the nitrogen- and phosphorus-treated lots were identical (table 3). The results show that the addition of phosphorus in combination with nitrogen was necessary for the production of grain.

Chemical and physical properties of the media. The nitrogen-treated lots had lower pH value than lot 1 (control) and the phosphatic-treated lots (table 4). Lyon, Buckman, and Brady (1952) stated that nitrogen-containing materials have residual effects on the soil. They pointed out that compounds which supply ammonium nitrogen, whether directly or indirectly or as a result of hydrolysis, ultimately increase soil acidity.

The application of hyperphosphate, superphosphate, thermophos, ammonium phosphate, and ammonium sulfate either singly or in combination had no effect on the water-holding capacity of the soil (table 5).

The application of ammonium sulfate, hyperphosphate, superphosphate, and ammonium phosphate did not alter the sticky point of the soil (table 6).

The different fertilizers had no marked effect on the rolling-out limit of the soil (table 7).

The application of phosphorus alone or in combination with nitrogen failed to increase or decrease the total nitrogen content of the soil after harvest (table 8). The same trend of results was observed by Galvez and Bueno (1951) and by Jose.[9] The same workers stated

[8] *Ibid.*

[9] Isidoro Jose, "The Effects of Nitrogen, Phosphorus, and Potassium Added Singly or in Combination to Lipa Clay Loam Planted to Rice." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1953. Unpublished.)

that if leaching were allowed, the fertility of the soil would equal that of the unfertilized lots.

The addition of nitrogen and phosphorus singly or in combination did not affect the amount of organic matter in the soil (table 9).

The addition of phosphate or phosphorus in the form of either superphosphate or hyperphosphate appreciably increased the amount of available phosphorus in the soil. Phosphorus in the form of thermophos, however, failed to raise the amount of available phosphorus in the soil (table 10). This result supports the finding of Minami (1950). The residual effects of hyperphosphate were similar to those of superphosphate when the initial application was heavy.

Of the nitrogen-treated lots, lot V treated with ammonium phosphate had very much less available phosphorus than those treated with hyperphosphate, but it had notably more than the thermophos-treated lot II. This shows that superphosphate and hyperphosphate had better residual effects than either thermophos or ammonium phosphate. Ammonium phosphate was better than thermophos in this respect.

The application of phosphorus either singly or in combination with ammonium sulfate appreciably diminished the amount of available potassium in the soil in favor of the control (table 11). Lots II, III, IV, and V had identical amounts of available potassium which were significantly higher than the amounts available in lots VI, VII, and VIII. The causes for the changes that took place in the soil are not clear, but the reduction of the amount of available potassium may have been due to the application of phosphorus singly or in combination.

The application of hyperphosphate, superphosphate, ammonium phosphate, and ammonium sulfate did not affect the amount of available calcium in the soil (table 12). Neither did it affect the amount of available magnesium (table 13).

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TABLE 1

Height in centimeters of the corn plants at maturity

TREATMENT	REPLICATION				TOTAL	MEAN
	1	2	3	4		
I Soil alone	122.50	92.00	81.50	104.50	400.50	100.1
II Soil plus thermophos	92.25	70.75	76.00	83.00	320.00	80.0
III Soil plus hyperphosphate	117.75	61.75	77.25	114.00	370.75	92.7
IV Soil + superphosphate	97.00	129.50	105.75	108.00	440.25	110.1
V Soil + ammonium phosphate	221.75	166.50	172.50	197.75	758.50	189.5
VI Soil + thermophos + ammonium sulfate	172.00	210.00	197.73	234.00	813.73	203.4
VII Soil + hyperphosphate + ammonium sulfate	205.25	217.75	180.00	200.50	803.50	200.9
VIII Soil + superphosphate + ammonium sulfate	195.25	212.25	207.25	178.00	792.75	198.2

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatments	7	86,098.23	12,299.75	31.55	2.43	3.50
Pots within treatment	24	9,357.89	389.98			
Total	31	95,455.59				

L.S.M.D. = 28.73

TABLE 2

Oven-dry weight of stover in grams

TREATMENT	REPLICATION				TOTAL	MEAN
	1	2	3	4		
I Soil alone	47.0	34.5	35.7	37.5	154.7	38.7
II Soil plus thermophos	38.0	32.6	37.1	32.9	140.6	35.2
III Soil plus hyperphosphate	42.7	39.5	38.3	37.7	158.2	39.6
IV Soil + superphosphate	42.1	40.0	47.1	56.7	185.9	46.5
V Soil + ammonium phosphate	121.1	102.5	124.9	155.6	504.1	126.0
VI Soil + thermophos + ammonium sulfate	107.2	154.3	122.3	147.3	531.1	132.8
VII Soil + hyperphosphate + ammonium sulfate	162.6	136.5	126.9	133.9	559.9	140.0
VIII Soil + superphosphate + ammonium sulfate	112.9	170.3	158.8	131.9	573.9	143.5

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatments	7	74,118.98	10,588.43	42.80	2.43	3.50
Pots within treatment	24	5,937.01	247.38			
Total	31	80,055.91				

L.S.M.D. = 22.96

TABLE 3

Oven-dry weight of grains in grams

	TREATMENT	REPLICATION 1	2	3	4	TOTAL	MEAN
I	Soil alone [a]	—	—	—	—	—	—
II	Soil plus thermophos [a]	—	—	—	—	—	—
III	Soil plus hyperphosphate [a]	—	—	—	—	—	—
IV	Soil + superphosphate [a]	—	—	—	—	—	—
V	Soil + ammonium phosphate	39.90	50.00	26.08	39.90	155.97	38.99
VI	Soil + thermophos + ammonium sulfate	41.24	31.29	36.92	29.49	138.94	34.74
VII	Soil + hyperphosphate + ammonium sulfate	48.32	39.29	61.54	42.61	191.76	47.94
VIII	Soil + superphosphate + ammonium sulfate	54.25	34.42	66.24	51.21	206.12	51.53

[a] Corn plants did not bear ears.

TABLE 4

Soil pH value

TREATMENT	REPLICATION				TOTAL	MEAN
	1	2	3	4		
I Soil alone	5.86	5.85	5.79	5.84	23.34	5.84
II Soil plus thermophos	5.87	5.93	5.86	5.90	23.56	5.89
III Soil plus hyperphosphate	6.07	6.11	6.16	6.10	24.34	6.09
IV Soil + superphosphate	5.71	5.74	5.72	5.73	22.90	5.73
V Soil + ammonium phosphate	5.51	5.41	5.49	5.51	21.92	5.48
VI Soil + thermophos + ammonium sulfate	5.41	5.60	5.55	5.58	22.14	5.54
VII Soil + hyperphosphate + ammonium sulfate	5.50	4.49	5.25	5.28	20.52	5.13
VIII Soil + superphosphate + ammonium sulfate	5.18	5.36	5.19	5.29	21.02	5.26

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatments	7	2.99	.43	16.53	2.43	3.50
Pots within treatment	24	.63	.026			
Total	31	3.62				

L.S.M.D. = 0.35

TABLE 5

Water-holding capacity of the soil in per cent

TREATMENT	REPLICATION 1	2	3	4	TOTAL	MEAN
I Soil alone	38.98	41.26	36.21	42.02	158.47	39.62
II Soil plus thermophos	39.09	37.41	43.31	39.41	159.22	39.85
III Soil plus hyperphosphate	36.02	39.46	43.55	38.25	157.28	39.32
IV Soil + superphosphate	37.92	40.92	40.34	38.96	158.14	39.54
V Soil + ammonium phosphate	38.46	41.21	39.21	39.72	158.60	39.65
VI Soil + thermophos + ammonium sulfate	39.11	42.14	36.14	42.24	159.63	39.98
VII Soil + hyperphosphate + ammonium sulfate	37.96	42.87	30.69	38.49	159.01	39.53
VIII Soil + superphosphate + ammonium sulfate	37.91	40.02	38.87	42.29	159.09	39.79

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE 5%	1%
Treatments	7	.94	0.13	0.02	2.43	3.50
Pots within treatment	24	129.20	5.38			
Total	31	130.14				

TABLE 6

Sticky point of soil in per cent

TREATMENT	REPLICATION				TOTAL	MEAN
	1	2	3	4		
I Soil alone	47.41	39.01	38.01	38.61	153.04	38.26
II Soil plus thermophos	36.12	38.09	38.95	38.97	152.12	38.02
III Soil plus hyperphosphate	39.02	37.01	39.90	36.05	151.98	38.00
IV Soil + superphosphate	35.01	39.96	38.78	42.09	155.84	38.96
V Soil + ammonium phosphate	36.23	38.84	39.03	39.11	153.21	38.33
VI Soil + thermophos + ammonium sulfate	37.41	37.96	38.23	39.86	153.46	38.37
VII Soil + hyperphosphate + ammonium sulfate	39.41	38.01	37.34	39.77	154.53	38.63
VIII Soil + superphosphate + ammonium sulfate	38.31	37.09	37.39	38.95	151.74	37.94

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatments	7	3.40	0.49	0.20	2.43	3.50
Pots within treatment	24	57.95	2.45			
Total	31	61.35				

TABLE 7

Rolling-out limit of soil in per cent

	REPLICATION				TOTAL	MEAN
	1	2	3	4		
I Soil alone	15.97	16.78	17.14	16.54	66.43	16.61
II Soil plus thermophos	16.54	16.23	16.83	16.12	65.72	16.63
III Soil plus hyperphosphate	16.03	16.77	17.45	15.93	66.18	16.55
IV Soil + superphosphate	15.76	16.83	16.43	16.67	65.69	16.42
V Soil + ammonium phosphate	14.97	17.21	16.93	16.77	65.88	16.47
VI Soil + thermophos + ammonium sulfate	15.86	16.98	17.31	16.23	66.39	16.60
VII Soil + hyperphosphate + ammonium sulfate	16.93	16.35	16.34	16.01	65.63	16.41
VIII Soil + superphosphate + ammonium sulfate	16.96	16.22	16.09	16.11	65.38	16.35

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatments	7	0.25	0.04	0.10	2.43	3.50
Pots within treatment	24	8.53	0.36			
Total	31	8.83				

TABLE 8

Total nitrogen content of soil in per cent

TREATMENT	REPLICATION				TOTAL	MEAN
	1	2	3	4		
I Soil alone	0.127	0.141	0.099	0.142	0.509	0.127
II Soil plus thermophos	0.071	0.121	0.119	0.152	0.463	0.116
III Soil plus hyperphosphate	0.125	0.130	0.108	0.118	0.481	0.123
IV Soil + superphosphate	0.094	0.147	0.092	0.108	0.441	0.110
V Soil + ammonium phosphate	0.112	0.125	0.118	0.130	0.485	0.121
VI Soil + thermophos + ammonium sulfate	0.106	0.121	0.106	0.104	0.437	0.109
VII Soil + hyperphosphate + ammonium sulfate	0.095	0.112	0.099	0.099	0.405	0.101
VIII Soil + superphosphate + ammonium sulfate	0.140	0.125	0.123	0.125	0.513	0.128

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatments	7	0.0021	0.00030	0.78	2.43	3.50
Pots within treatment	24	0.0092	0.00038			
Total	31	0.0113				

TABLE 9

Organic-matter content of the soil in per cent

	TREATMENT	REPLICATION 1	2	3	4	TOTAL	MEAN
I	Soil alone	2.28	2.39	2.41	1.68	8.76	2.19
II	Soil plus thermophos	1.20	2.02	2.20	2.58	8.00	2.00
III	Soil plus hyperphosphate	2.13	2.21	1.83	2.00	8.17	2.43
IV	Soil + superphosphate	1.61	2.49	1.56	1.83	7.49	1.88
V	Soil + ammonium phosphate	1.90	1.12	2.00	2.21	7.23	1.81
VI	Soil + thermophos + ammonium sulfate	1.80	2.05	1.80	1.79	7.44	1.86
VII	Soil + hyperphosphate + ammonium sulfate	1.61	2.00	1.63	1.78	7.07	1.77
VIII	Soil + superphosphate + ammonium sulfate	1.38	1.12	2.00	2.09	6.59	1.65

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE 5%	1%
Treatments	7	0.83	0.1186	0.813	2.43	3.50
Pots within treatment	24	3.50	0.1458			
Total	31	4.33				

TABLE 10

Available phosphorus content of soil in parts per million

TREATMENT	REPLICATION				TOTAL	MEAN
	1	2	3	4		
I Soil alone	36	46	29	27	138	34.5
II Soil plus thermophos	41	45	34	48	168	42.0
III Soil plus hyperphosphate	113	91	153	109	466	116.3
IV Soil + superphosphate	96	86	100	99	381	95.3
V Soil + ammonium phosphate	78	86	83	84	331	82.8
VI Soil + thermophos + ammonium sulfate	41	41	44	51	177	44.3
VII Soil + hyperphosphate + ammonium sulfate	125	100	121	106	452	113.0
VIII Soil + superphosphate + ammonium sulfate	109	87	150	96	442	110.5

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatments	7	33,534.97	4,790.71	21.46	2.43	3.50
Pots within treatment	24	5,357.25	223.22			
Total	31	38,892.22				

TABLE 11

Available potassium content of the soil in parts per million

TREATMENT	REPLICATION				TOTAL	MEAN
	1	2	3			
I Soil alone	108	121	115	112	456	144.0
II Soil plus thermophos	99	86	91	81	357	89.3
III Soil plus hyperphosphate	91	101	74	86	352	88.0
IV Soil + superphosphate	75	108	74	106	363	90.8
V Soil + ammonium phosphate	71	79	75	86	311	77.8
VI Soil + thermophos + ammonium sulfate	66	48	65	75	254	63.5
VII Soil + hyperphosphate + ammonium sulfate	57	48	64	65	234	58.5
VIII Soil + superphosphate + ammonium sulfate	55	63	61	53	232	58.0

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatments	7	10,578.72	1,511.25	14.74	2.43	3.50
Pots within treatment	24	2,460.25	102.51			
Total	31	13,038.97				

TABLE 12

Available calcium content of the soil in parts per million

TREATMENT	REPLICATION				TOTAL	MEAN
	1	2	3	4		
I Soil alone	900	900	800	940	3,540	885.0
II Soil plus thermophos	890	1,000	650	900	3,440	860.0
III Soil plus hyperphosphate	945	850	780	1,100	3,675	918.8
IV Soil + superphosphate	890	925	950	930	3,695	923.8
V Soil + ammonium phosphate	930	770	800	860	3,360	840.0
VI Soil + thermophos + ammonium sulfate	900	800	790	1,025	3,515	878.7
VII Soil + hyperphosphate + ammonium sulfate	890	900	790	915	3,495	883.8
VIII Soil + superphosphate + ammonium sulfate	850	840	890	950	3,530	882.5

Analysis of variance

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE	
					5%	1%
Treatments	7	21,661.88	3,094.55	0.36	2.43	3.50
Pots within treatment	24	204,385.00	8,516.04			
Total	31	226,046.88				

TABLE 13

Available magnesium content of the soil in parts per million

TREATMENT	REPLICATION 1	2	3	4	TOTAL	MEAN
I Soil alone	36	39	36	30	141	35.3
II Soil plus thermophos	21	39	38	30	128	32.0
III Soil plus hyperphosphate	45	38	26	31	140	35.0
IV Soil + superphosphate	33	38	35	37	150	38.5
V Soil + ammonium phosphate	40	45	40	37	155	38.5
VI Soil + thermophos + ammonium sulfate	41	38	40	27	146	36.5
VII Soil + hyperphosphate + ammonium sulfate	40	38	35	27	140	35.0
VIII Soil + superphosphate + ammonium sulfate	40	25	42	40	147	36.7

SOURCE OF VARIANCE	DF	SUM OF SQUARES	MEAN SQUARE	COMPUTED F-VALUE	TABULAR F-VALUE 5%	1%
Treatments	7	115.97	16.57	0.42	2.43	3.50
Pots within treatment	24	958.25	39.93			
Total	31	1,074.22				3.50

CAROTENE, VITAMIN A, CALCIUM, AND INORGANIC PHOSPHORUS CONTENTS OF THE BLOOD PLASMA OF CATTLE AND CARABAOS [1]

ALVARO N. BALCITA, G. V. GARCIA, LOLITA AUSTRIA, L. A. YNALVEZ, AND J. K. LOOSLI

The cattle showed a mean plasma carotene value of 126 ± 4.4 ug. per 100 ml. in January and a significantly lower mean of 57 ±3.4 ug. in April. There were no significant differences in carotene content of plasma among the animals of different ages, sexes, and breeds. None of the carabaos or buffaloes had any carotene in their blood plasma.

The mean plasma vitamin A content was 189 ± 13.9 ug. per 100 ml. in January and 117 ± 7.8 in April. The cattle exhibited a significantly higher mean value of 176 ± 11.7 than the carabaos and buffaloes, which had 127 ± 13.2. The blood plasma of males and females and young and mature animals did not not differ significantly in vitamin A content.

There were no significant seasonal or sex differences in the calcium or phosphorus contents of the blood plasma of the animals. The cattle had a significantly higher calcium value of 10.8 ± .55 than the carabaos and buffaloes, which had 7.7 ± .53 mg. per 100 ml. Young animals had more plasma phosphorus than mature animals.

In the Philippines studies have never been conducted to establish the normal values of the blood constituents of farm animals, except those of hemoglobin and the blood cells. The diagnostic worth of blood analyses depends upon the existence of a reliable body of knowledge on the expected values in healthy and diseased animals. The prevalent finding [2] in the Philippines that the hemoglobin content of the blood of healthy animals is appreciably lower than that of the same species in temperate climates emphasizes the need for research on blood analyses.

EXPERIMENTAL METHODS

Two series of analyses were made of the carotene, vitamin A, calcium, and phosphorus contents of the blood plasma of yearling and mature males and females of native and Nellore cattle, carabaos, and Indian Murrah buffaloes (table 1). The first series was made in January when the grass was green and the second series in April, toward the end of the dry season, when the grass was dry. Sixteen animals were studied in each of the two series.

The animals studied were cared for in the same way as the other animals in the College herd. They were bled by venopuncture. The

[1] Central Experiment Station Contribution No. 1788.

[2] M. Manresa and S. C. Orig, *Philippine Agriculturist*, 30, 375 (1941).

L. L. Calo, "A Study on the Pulse Rate, Frequency of Respiration, Body Temperature, Hemoglobin Index, and Blood Cell Counts of Holstein-Friesian Dams and their Daughters." (Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, 1954. Unpublished.)

blood was drawn from the jugular vein by a syringe, transferred into 30-ml. centrifuge tubes containing sodium citrate crystals, and thoroughly mixed to prevent clotting. After chilling in cold water, the samples were centrifuged at 1500 to 1700 rpm. for 15 to 30 minutes, and the clear plasma was decanted into clean, dry test tubes. Carotene and vitamin A analyses were completed within a few hours after the blood had been drawn. The plasma was usually refrigerated a day or two before the calcium and phosphorus contents were determined.

The methods used for the analyses of carotene and vitamin A were essentially those of Kimble,[3] except that a Coleman Universal spectrophotometer was used for taking the readings. Inorganic phosphorus was analyzed by the methods of Youngberg [4] and the AOAC, also with the use of a Universial Coleman spectrophotometer, and calcium was analyzed by the usual titration procedure.

DISCUSSION OF RESULTS

The carabaos and buffaloes had no measurable carotene in their plasma (table 2). The mean values for cattle were significantly higher in January than in April when the grass was dry. The mean value of 126 ± 4.4 ug. of carotene per 100 ml. of plasma is lower than that reported in the United States for mature cattle on good pasture.[5] The cause of this difference is not known, but it may lie in the difference in breed of the cattle, type of pasture, or climatic factors. The significantly lower carotene value in April (57 ± 3.4 ug./100 ml.) following a mild dry period of only six weeks illustrates the close correlation between carotene intake and blood carotene that was also observed in other countries.

Plasma vitamin A values followed the same seasonal trend as carotene. The significant decrease from 189 ± 13.9 ug. to 117 ± 7.8 ug. per 100 ml. of plasma during the short dry period suggests that the extended dry periods of six to seven months which occur each year in central and northern Luzon may cause vitamin A deficiency. The question should be studied in these areas. The observed vitamin A values are somewhat higher than those recorded in the United States; the explanation for this is not apparent. The cattle had significantly higher values than the carabaos and buffaloes. Differences in age or sex of the animals did not influence vitamin A or carotene values.

The plasma values for calcium are approximately the same as those reported in other countries. The cattle exhibited significantly higher plasma values than the carabaos and buffaloes. There were

[3] M. S. Kimble, *Jour. Lab. Clin. Med.*, 24, 1005 (1939).
[4] M. McCay and R. G. Warner, "Laboratory Manual for Animal Nutrition," Cornell Univ., Ithaca, N.Y., 111 pp.
[5] T. S. Sutton and P. A. Soldner, *Jour. Dairy Sci.*, 28, 859 (1945).

no significant differences between old and young animals, between males and females, or between the January and April series.

Age was the only factor which caused a significant difference in mean inorganic phosphorus values. The yearlings had a mean value of 5.0 ± 0.30 mg. of phosphorus per 100 ml. of plasma, and the mature animals had 3.8 ± 0.23 mg.

TABLE 1

Herd number, age, breed, and sex of the animals used in the experiment

HERD NO.	BREED	DATE OF BIRTH	AGE [a]		SEX
			yr.	*mo.*	
19	Native cattle	July, 1941	12	5	Male
4	" "	About 1942	11	—	Female
45	" "	Feb. 18, 1953	0	10	Male
41	" "	Jan. 24, 1953	0	11	Female
3	Nellores	July, 1945	8	5	Male
1	"	About 1937	16	0	Female
11	"	June 30, 1951	2	6	Male
12	"	Aug. 14, 1951	2	4	Female
1	Native carabaos	About 1945	9	0	Male
7	" "	May, 1947	6	9	Female
15	" "	Feb. 4, 1953	0	10	Male
110	" "	Nov. 15, 1952	1	1	Female
5	Murrah buffaloes	About 1949	5		Male
2	" "	About 1945	9		Female
18	" "	Aug. 20, 1952	1	2	Male
19		Oct. 30, 1952	1	1	Female

[a] As of January 1, 1954.

TABLE 2

Mean plasma levels of carotene, vitamin A, calcium, and phosphorus showing significance of the differences observed

ANIMALS AND PLASMA VALUES	DF	"t" VALUES		
		Observed	Required at	
			1%	5%
Carotene				
Carabaos and buffaloes, none	—	—	—	—
All cattle: January, 126 ± 4.4 ug; April, 57 ± 3.4 ug.	14	12.51	2.15	2.98
Vitamin A				
January, 189 ± 13.9 ug.; April, 117 ± 7.8 ug.	30	4.89	2.04	2.75
Cattle, 176 ± 13.9 ug.; carabaos and buffaloes, 127 ± 13.2 ug.	30	2.43	2.04	2.75
Calcium				
Cattle, 10.8 ± 0.55 mg.; carabaos and buffaloes, 7.7 ± 0.53 mg.	30	3.92	2.04	2.75
Phosphorus (inorganic)				
Yearlings 5.0 ± 0.30 mg.; mature animals, 3.8 ± 0.23 mg.	30	3.51	2.04	2.75

METHODS OF PROPAGATING SANSEVIERIA [1]

EPHRAIM M. ORTEZA

WITH ONE TEXT FIGURE

Rootstocks of *Sansevieria trifasciata* var. *laurentii* (De Willdem.) N. E. Br. proved to be better propagating materials than suckers or leaf cuttings. They rooted the earliest, within an average period of 18.20 days, and had the highest average percentage of sucker production, 98.5 per cent. The plants produced from rootstocks were the tallest and had the highest average number of leaves 120 days after planting. Eight months after transplanting, they were taller than the plants from the leaf cuttings and the suckers.

Sansevieria is one of the new fiber plants. It is highly regarded in the field of commerce and industry because of its widespread availability. Also known as bowstring hemp, Sansevieria was reported by Matthews [2] to be a plant belonging to the Liliaceae family indigenous to Africa and India. In tropical countries today it is either cultivated or wild.

According to Nicholls [3] the genus Sansevieria is extensive. It includes several species which produce fiber known as bowstring hemp. The species are all perennial plants. The leaves may be flat or cylindrical or semicylindrical. They measure 1 inch thick from side to side and 1¼ inches to 1¾ inches from front to back. The leaves originate either from a creeping rootstock or from a short hidden stem crowded near the base.

Matthews [4] described the Sansevieria fiber as soft in texture, light in color, and of a tensile strength comparable to that of the best grade of sisal fiber. It is used in the manufacture of cordage, mats, and extremely coarse cloths, blended with other structural fibers in the manufacture of rope, and used for sewing sacks and the soles of leather shoes.[5]

Sansevieria is best propagated by division of rootstocks although it may be raised from seeds or from whole leaves or pieces of leaves planted as cuttings.[6] The plant grows favorably in well-drained

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[1] Central Experiment Station Contribution No. 1789. Thesis presented for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture, April, 1954. Prepared in the Department of Agronomy under the direction of Dr. Pedro A. David.

[2] Joseph Merritt Matthews, "Matthews' Textile Fibers," J. Wiley and Sons, Inc., London, 1947, 5th ed.

[3] Sir Henry Alford Nicholls, "A Textbook of Tropical Agriculture," MacMillan and Co., Limited, London, 1929.

[4] Matthews, *op. cit.*

[5] Stated by Mr. Antonio Lejano, Manager of the Fiber Inspection Service, at an interview.

[6] Matthews, *op. cit.*

and moderately fertile soil at a distance of planting of 3 feet by 3 feet. Its cultural and climatic requirements are approximately the same as those of sisal or Mauritius hemp.[7] Under favorable conditions, a fair estimate of its yield would be 1½ tons of dry fiber to an acre.

Since Sansevieria grows wild in the Philippines and is readily available as a source of fiber, information as to the best local method of propagation for early production of suckers would be of great value to Filipino farmers. This study was therefore conducted from December, 1952, to January, 1954, in the Central Experiment Station and in the Department of Agronomy.

MATERIALS AND METHODS

Six hundred pieces of leaves, suckers, and rootstocks of *Sansevieria trifasciata* variety *laurentii* (De Willdem.) N. E. Br.[8] were planted in 12 seedboxes filled with ordinary clay loam soil. Only 50 seed pieces were planted in each seedbox. Records were taken of sucker production, time of rooting, height, and number of leaves at the time of transplanting. A propagating material was considered rooted when the roots were about two millimeters long.

One hundred twenty days after planting, seven peices of each kind of planting material were transplanted to a field plot of 189 square feet. The distance of planting was 3 feet by 3 feet. The three kinds of propagating materials were transplanted at random to each of the seven blocks in the field. The field test was conducted to observe the growth, resistance to pests and diseases, height, number of leaves, and number of suckers of each kind of propagating material.

RESULTS AND DISCUSSION

Germination test

Time of rooting. Earliest rooting was observed to occur among the rootstocks and the latest, among the leaf cuttings (table 1).

Sucker production. One hundred days after the planting materials had been planted in the seedboxes, the number of plants that suckered were counted and expressed in per cent. The lowest percentage of sucker production was 82 and the highest was 100; the average was 90.17 (table 2).

Height of plants. The heights of the suckers produced from the 21 propagating materials for transplanting were measured 120 days after planting in the seedboxes. The shortest sucker was 3 centimeters and the tallest was 11.6 centimeters; the average was 8.05 centimeters (table 3). The analysis of variance shows that the

[7] Nicholls, *op. cit.*

[8] Identified by Mr. Juan V. Pancho of the Department of Agricultural Botany.

heights of the plants differed significantly. Rootstocks and suckers gave significantly taller plants than the leaf cuttings.

Number of leaves. The smallest number of leaves to a plant among the suckers 121 days after planting in the seedboxes was one, and the highest was four (table 4). The over-all average number of leaves to a sucker was 2.09.

Field test

Nature of growth. The plants exhibited luxuriant growth in the field. Observations showed that *Sansevieria trifasciata* variety *laurentii* (DeWilldem.) N.E. Br. can hold its own against the weeds.

Pests and diseases. No pests or diseases were found on the experimental plants.

Number of leaves. Eight months after transplanting in the field, the number of leaves was determined. The lowest number of leaves to a plant was 5, and the highest number was 17 (table 5). The rootstocks and suckers had more leaves to a plant than the leaf cuttings because the first two propagating materials rooted earlier and produced suckers earlier.

Height of plants. Eight months after transplanting, the tallest plant was 25.5 centimeters and the shortest was 12.7 centimeters (table 6). The differences in height among the plants were significant.

Number of suckers. The highest number of suckers eight months after transplanting in the field was nine, and the lowest was two (table 7). In all the methods of propagation, the average number of suckers produced was 5.71.

Additional observation. One peculiarity was observed on all the leaves of suckers produced from leaf cuttings.[9] The leaves lacked the yellow strip along the margin which was present on the mother leaves and on the leaves of suckers produced from the other kinds of propagating materials (fig. 1).

[9] This phenomenon was noted and verified by Dr. José M. Capinpin of the Department of Agricultural Botany.

Fig. 1.—The different propagating materials: left to right, rootstocks, suckers, and leaf cuttings. *(Photographed by Photographic Division, College of Agriculture.)*

TABLE 1

Number of days of rooting [a]

PROPAGATING MATERIAL	REPLICATION				TOTAL	MEAN
	1	2	3	4		
Suckers	17.36	19.04	18.75	18.81	73.96	18.49
Leaf cuttings	35.27	35.64	35.04	36.02	141.97	35.49
Rootstocks	17.31	17.40	19.28	18.83	72.82	18.21
Total	69.94	72.08	73.97	73.66	288.75	24.06

[a] The figures were averages of 50 observations.

TABLE 2

Percentage of plants that produced suckers

PROPAGATING MATERIAL	REPLICATION				TOTAL	MEAN
	1	2	3	4		
Suckers	88	88	82	84	342	85.5
Leaf cuttings	86	88	82	90	346	86.5
Rootstocks	98	100	98	98	394	98.5

TABLE 3

Height of plants in centimeters 120 days after planting in seedboxes

PROPAGATING MATERIAL	REPLICATION							TOTAL	MEAN
	1	2	3	4	5	6	7		
Suckers	9.9	10.2	10.4	9.0	10.3	10.5	10.1	70.4	10.06
Leaf cuttings	2.8	3.0	2.7	3.1	3.3	4.2	3.6	22.7	3.24
Rootstocks	10.3	10.0	11.1	11.0	11.3	11.6	10.8	76.1	10.87
Total	23.0	23.2	24.2	23.1	24.9	26.3	24.5	169.2	8.05

Analysis of variance

SOURCE OF VARIANCE	DF	SS	MS	COMPUTED F-VALUE	TABULAR F-VALUE	
					.05	.01
Replications	6	2.87	.48	2.67	3.88	6.93
Propagating materials	2	245.68	122.84	682.44		
Error	12	2.16	.18			
Total	20	250.71				

L.S.M.D. = 4.85

TABLE 4

Number of leaves to a plant when transplanted

PROPAGATING MATERIAL	REPLICATION							TOTAL	MEAN
	1	2	3	4	5	6	7		
Suckers	2	2	2	1	3	1	2	13	1.86
Leaf cuttings	1	1	2	1	1	2	1	9	1.29
Rootstocks	3	2	3	4	4	4	2	22	3.14

TABLE 5

Number of leaves to a plant eight months after transplanting

PROPAGATING MATERIAL	REPLICATION							TOTAL	MEAN
	1	2	3	4	5	6	7		
Suckers	13	12	11	16	11	10	11	84	12.00
Leaf cuttings	8	7	5	12	5	7	8	52	7.12
Rootstocks	17	11	16	13	9	13	16	95	13.57

TABLE 6

Height of plants eight months after transplanting

PROPAGATING MATERIAL	REPLICATION							TOTAL	MEAN
	1	2	3	4	5	6	7		
Suckers	19.6	17.2	18.5	14.9	16.2	18.0	16.7	121.1	17.30
Leaf cuttings	13.7	14.0	14.2	12.7	13.0	14.3	13.8	95.7	13.67
Rootstocks	23.2	23.0	25.5	24.8	25.0	24.7	21.5	167.7	23.95
Total	56.5	54.2	58.2	52.4	54.2	57.0	52.0	384.5	18.30

Analysis of variance

SOURCE OF VARIANCE	DF	SS	MS	COMPUTED F-VALUE	TABULAR F-VALUE	
					.05	.01
Replications	6	11.17	1.86	1.25		
Propagating materials	2	390.98	190.49	127.84	3.88	6.93
Error	12	17.85	1.49			
Total	20	410.00				

L.S.M.D. = 0.45

TABLE 7

Number of suckers eight months after transplanting

PROPAGATING MATERIAL	REPLICATION							TOTAL	MEAN
	1	2	3	4	5	6	7		
Suckers	7	6	6	8	5	5	6	43	6.14
Leaf cuttings	4	3	3	5	2	4	5	26	3.71
Rootstocks	9	7	8	8	4	7	8	51	7.28

INVESTMENT AND INCOME OF 107 TENANT FARMERS IN SAN PABLO CITY IN 1952 [1]

L. S. Robertson and C. A. Bratton [2]

The tenant farmers averaged 41 years of age, 2.7 years of education, and 20 years of farming experience. The 107 farms averaged 2.7 hectares, 2 hectares of which were in coconuts and .7 hectare was in lowland rice. The average number of livestock on the farms was .8 carabao, .7 sow, 2.9 pigs, 2.8 hens, 1.4 pullets, 1.2 roosters, and 5 chicks. The landowner usually received 70 per cent of the coconuts and none of the intercrop. Lowland rice was divided equally.

Tenant capital ranged from ₱316 to ₱5722 and averaged ₱1166. The farm receipts to a farm averaged ₱1088; operating expenses, ₱830; net farm income, ₱258; farm labor income, ₱188; privileges, ₱283; and farm labor earnings, ₱471. Tenant families had average nonfarm receipts of ₱190 for the operator and ₱195 for the other members. The amount available for family living, education, investment, savings, and other purposes averaged ₱990.

Volume of business was the most important factor affecting tenant farm returns. Yield of coconuts probably was closely related to landlord income, but not to tenant income. Tenant farm earnings were influenced more by the other crops than by the coconut crop because the tenants got one-half of the lowland rice and all of the intercrop, but only a relatively small share of the coconuts.

What income do tenants make in a coconut farming area? What farm capital and labor do they use? How do incomes vary from farm to farm? What causes the variation?

Answers to questions such as these were sought in a study of 107 tenant farms in San Pablo City in 1953. The answers are useful to tenant farmers who are trying to increase their incomes. They are useful also to officials who legislate and serve in public positions.

THE AREA

San Pablo City is in the rolling upland coconut area of southeastern Laguna in southern Luzon. The 107 tenant farms studied were scattered over 18 of the 48 barrios in San Pablo City. These barrios were from 2 to 15 kilometers away from San Pablo City proper. A few were on the provincial road, but others were on rugged side roads or on paths.

In the more peaceful barrios the farmers lived near their farms, but elsewhere they lived near the poblacion, some as far as 5 to 10 kilometers from their farm land. Of the 18 barrios, 7 had electricity and 10 had water systems. Only 3 of the 18 barrios had irriga-

[1] Central Experiment Station Contribution No. 1790. Prepared in the Department of Agricultural Economics.

[2] Acknowledgment is due to Mr. Domiciano E. Raymundo for his assistance in gathering the information and to Professor N. B. Tablante for his suggestions.

tion. Although an attempt was made to study representative tenant farms, it is probable that the farms actually surveyed were slightly better than average for San Pablo City, largely because getting information from some of the remote areas would have involved too great a risk.

Characteristics of the tenants

The tenants averaged 41 years of age. Three-fourths of them were from 28 to 48 years.

The average school grade that the tenants had reached was 2.7. Thirty-seven had had no schooling. Younger tenants tended to have more schooling than older tenants.

The tenants had farmed an average of 20 years, 14 of which were on the farms they were on during the survey. None of the tenants reported belonging to any association, reading any newspaper regularly, or keeping any accounts. All but four borrowed money; 54 per cent borrowed from their landlords, 41 per cent from relatives, and 5 per cent from both. None had heard of the Agricultural Credit and Cooperative Financing Administration (ACCFA), now in its first year of operation.

How the tenants farmed

Use of land. The farms operated by the 107 tenants ranged in size from 1 to 30 hectares. Only one was more than 7 hectares. The average size was 2.7 hectares.

On the average 2 hectares were in coconuts and .7 hectare was in lowland rice. Eighty farms planted no lowland rice; 25 farms, mostly the larger ones, either had as many hectares in lowland rice as in coconuts or had more hectares in lowland rice.

It was common practice to plant crops like corn, upland rice, gabi, and sweet potatoes between the coconut trees. On the average, 1.4 hectares were thus intercropped. This practice was followed on all farms of not more than 2 hectares, but only on about one-fourth of farms larger than 3.5 hectares.

Livestock. One-third of the 26 farms with less than 2 hectares had 1 carabao each; one farm had 2 carabaos. Seven-eights of the 48 middle-sized farms (2 to 3½ hectares) had 1 to 3 carabaos. All but one of the 23 large farms had from 1 to 8 carabaos. The average for all farms was 0.8.

All but 11 of the farms had hogs. Each farm had an average of .7 sow and 2.9 pigs.

Poultry was raised on two-thirds of the farms. Only two farms had as many as 12 hens. The farms had an average of 2.8 hens, 1.4 pullets, 1.2 roosters, and 5 chicks; only one farm had ducks.

Seventeen farms, mostly the small ones, each had one horse. Two farms had goats. None had cattle.

Tenure arrangements. On 90 of the 107 farms the tenant received 30 per cent of the coconuts and the landlord, 70 per cent. On 114 farms the tenant's share was only 15 per cent. On one farm where the tenant got 70 per cent and on another where he got 40 per cent, the intercrop was shared equally with the landlord. On the other farms the landlord did not share in the intercrop. The coconut buyers picked and piled the coconuts. The tenant's share was therefore largely the return for his keeping the plantation clean, protecting it, and supervising the harvesting.

Lowland rice was divided equally on all the farms where it was grown.

On only two farms did the landlord furnish the carabao. On two other farms the landlord furnished a few of the other livestock. The tenant provided the tools and implements on all farms.

The landlord furnished the land valued at an average of ₱2675 to a hectare. All operators lived in their own dwellings.

Coconut farming practices. Coconut trees were spaced 6 meters apart on 63 farms, 7 meters apart on 27 farms, and 8 meters apart on 16 farms. The average spacing was 6.6 meters.

The common intervals between harvests were 35 days on 54 of the farms, 40 days on 18 farms, and 45 days on 26 farms. The range was from 30 to 90 days, and the average was 39 days.

The average age of the coconut plantation was 67 years. All but one were at least 50 years old, and several were 80 years old.

Some cover crops were grown on the coconut plantations by all of the tenants.

Rice farming practices. Quezon and Thailand were the common varieties of lowland rice planted. Preparation of the land involved plowing once and harrowing two to four times (an average of 3.6) at average intervals of six days. Plants were grown mostly by the "dapog" method; some, particularly on the larger farms, were grown by the "punla" or ordinary wetbed method.

Lowland rice was irrigated on 24 of the 27 farms on which this crop was grown, but the water, affected by a processing plant, was not favorable to optimum plant growth. On the irrigated farms two crops of rice were grown during the year; on the others, only one crop was grown.

Labor. The farm provided employment for its operator for an average of 6.6 months during the year; for the operator's wife, 5 months; for the sons, 1.3 months; and for the daughters, 1 month. The total for the family was 8.5 months. Hired labor was used on only 15 farms except during rice planting.

Various kinds of work on coconuts and rice accounted for most of the man labor, as shown below:

	DAYS LABOR USED ON A FARM		
	Operator	*Family*	*Hired*
Plowing and cleaning coconut plantation	34	6	0
Repairing dikes	2	[a]	[a]
Preparing rice seedbed	3	[a]	[a]
Plowing for rice	7	1	0
Harrowing for rice	12	1	0
Planting rice	9	[a]	21
Other rice and coconut work	24	35	1
Miscellaneous	70	0	0
Total	161	43	22

[a] Less than 0.5.

Capital. Tenants had an average farm investment of ₱1166. The tenant's total capital to a farm ranged from ₱316 to ₱5722.

The dwelling constituted more than two-fifths of the tenant's capital, as shown below:

	TENANT'S CAPITAL TO A FARM	
	pesos	*per cent*
Dwelling	505	43
Work animals	310	27
Tools and equipment	175	15
Productive livestock	157	13
Supplies	19	2
Total	1,166	100

The landlord's capital on these farms, consisting almost entirely of real estate, averaged ₱7232 and ranged from ₱2000 to ₱32,500.

INCOMES MADE

Farm receipts. The tenant's total farm receipts averaged ₱1088. This included the value of crops turned over to the landlord and to the harvesters. Of the amount, ₱100 was an increase in inventory of supplies. The total did not include the value of products raised for family living, which is discussed later under farm privileges.

	AVERAGE RECEIPTS TO A TENANT	
	pesos	*per cent*
Crops sold	425	39
Crops to landlord	448	41
Crops to harvesters	81	7
Livestock and products sold	19	2
Increase in inventory	115	11
Total	1,088	100

Total receipts to a farm ranged from ₱171 to ₱5056. They were less than ₱400 on 25 farms, mostly the smaller ones.

Farm expenses. The operating expenses averaged ₱830 to a farm. They ranged among farms from ₱146 to ₱4400, the larger expenses tending to be on the larger farms.

The total expenses of the tenant included the value of crops turned over to the landlord and to the harvesters and the value of the labor of members of the family other than himself. The landlord's share of the crops constituted more than one-half of the total.

AVERAGE EXPENSES OF A TENANT	*pesos*	*per cent*
Crops to landlord	448	54
Crops to harvesters	81	10
Livestock bought	84	10
Buildings and tools	42	5
Hired labor	30	3
Value of unpaid family labor	64	8
Miscellaneous cash expenses	81	10
Total	830	100

Net income. The difference between farm receipts and farm income averaged ₱258 on the 107 tenant farms. On 23 of the farms the expenses were larger than the receipts. On six farms the receipts were more than ₱1000 higher than the expenses.

The farm income is the amount the tenant makes from the farm for the use of his capital and his labor. This does not include the products raised for home use. If the capital of the tenant is charged at 6 per cent, the remainder of the farm income can be assumed to be the tenant's labor income, or the pay he gets for his own labor. The average labor income of the 107 tenants was ₱188. Thirty-six of the tenants had minus labor incomes; their farm incomes were not enough to cover the interest on their capitals without considering any pay for their labor. Six others each made labor incomes of more than ₱1000.

Farm privileges. In calculating the farm income and the labor income, no credit was given for products furnished by the farm for family living. The average value of these farm privileges on the 107 farms was ₱283. Crops constituted nearly two-thirds of the total.

VALUE OF PRIVILEGES TO A FARM	*pesos*	*per cent*
Use of dwelling	96	34
Palay	84	30
Other crops	92	32
Hogs	9	3
Poultry	1	½
Eggs	1	½
Total	283	100

The privileges ranged among farms from ₱76 to ₱755. The value of the dwelling was the greatest factor influencing the total privileges. The value of livestock products consumed ranged from zero to ₱170. The value of rice consumed ranged from zero to ₱600.

The average palay consumption to a family was 8 cavans. The value of the miscellaneous crops consumed ranged from zero to ₱287.

Farm labor earnings. Farm labor earnings consist of the labor income plus the value of the farm privileges. On farms where a large share of the production is for family use rather than for sale, farm labor earnings constitute one of the best measures for comparing the profitability of farms. The farm labor earnings of a tenant averaged ₱471. Only 4 of the 107 tenants had minus labor earnings. Eleven each had more than ₱1000. One had ₱2227.

Nonfarm income. Eighty-eight of the 107 tenants had some income other than from the farm. The amount ranged from ₱48 to ₱500 and averaged ₱190 for all 107 farms. These earnings came largely from picking, hauling, and husking coconuts. The amount was less on large farms than on small farms.

The other members of the family also had sources of nonfarm income. This nonfarm family income ranged from zero on 35 farms to ₱600 or more on 7 farms. It averaged ₱195 for all 107 farms.

Amount available for family expenditures. The amount that tenant families had available to spend for living expenses, education, investment, savings, and other nonfarm expenditures was the sum of their net farm income, the value of the unpaid family labor, and the operator's and family members' nonfarm receipts. The amount averaged ₱990 on the 107 farms. It was less than ₱500 on only 7 farms and more than ₱1500 on 11 farms.

WHY SOME FARMS PAID MORE THAN OTHERS

Part of the variation in income among farms naturally was due to chance. Rain fell when it was needed on some farms but not on others. Winds damaged the crops of some farmers more than those of others. Diseases or pests struck some farms and not others through no fault of the operators.

Another large part of the variation in income from farm to farm was caused by factors which the operator could influence in the long run. In coconut farming the principal factor likely to influence profits is volume of business.

Volume of business. The larger coconut farms gave tenants much higher incomes than the smaller farms. Tenants on the smaller farms had higher nonfarm earnings, but not high enough to balance the lower farm returns.

	HECTARES TO A FARM		
	1-1½	*2-3½*	*4-20*
Average hectares	1.2	2.5	5.5
Number of farms	36	48	23
Operator's labor income (₱)	20	92	653
Operator's farm labor earnings (₱)	245	371	1,031
Amount available for family expenditures (₱)	759	956	1,425

Yield of coconuts. The average yield of coconuts on all 107 farms was 3164 nuts to a hectare. The yields ranged from 1500 to 1800 nuts.

In most types of farming, yield of the most important crop is one of the strongest factors affecting farm returns. Probably this factor had the greatest effect on the landowners' incomes on the 107 farms. No significant relationship, however, was found evident between coconut yields and the labor returns of the tenants, even after elimination of the possible "confounding" effect of size of farm and amount of lowland rice. The probable reason for this is that in old plantations where the trees were few and the coconut yields were low, the tenants' low coconut returns were offset by the higher returns from intercrops. The tenants kept all the returns from intercrops, but they got only a small share of the returns from coconuts.

Proportion of returns from coconuts. Tenants who depended largely on coconuts for farm receipts tended to be on farms where coconut yields were highest. These tenants made lower incomes than those with low coconut yields and comparatively more intercrops or lowland rice. The relationship is more striking when the influence of hectarage is minimized. In the 42 farms of 1 to 1½ hectares, there was a strong negative correlation between the percentage of total farm receipts from coconut and the farm labor income or farm labor earnings.

PERCENTAGE OF RECEIPTS FROM COCONUTS ON FARMS OF 1 TO 1½ HECTARES		YIELD OF COCONUTS TO A HECTARE	LABOR INCOME	LABOR EARNINGS
Range	*Average*			
1.0–16.0	7.9	2,800	₱396	₱720
16.1–32.0	25.3	2,440	193	434
32.1–100.0	48.1	4,039	−24	172

A PROGRAM FOR ANIMAL BREEDING AND IMPROVEMENT [1]

MIGUEL MANRESA, JR.

Considering the need for establishing the livestock population of the Philippines and in line with the current cooperation and extension service project of the College and other agencies of the government, the maintenance and improvement of the imported pure established breeds of livestock for use mainly in crossbreeding experiments and in extension work are necessary. Crossbreeding experiments should develop knowledge which will provide a sound basis for advising livestock raisers on what results to expect if they should decide to use crossbreeding as a means of producing better replacements for their animals.

Among the methods available to us of raising and improving livestock suitable to our conditions are (1) the improvement of the stock of animals which have become adapted to our climate and our methods of farming and (2) the formation of new breeds by blending the desirable characteristics of the eastern breeds with those which can live in the tropics. The feasibility and practicability of these methods have been demonstrated in other parts of the world and in the College as well. The first method has the advantage of availability to a number of livestock raisers. The second method takes many years of constant work and adherence to well-defined policies and objectives. Since there is need for animal breeding and improvement at the College, the sooner a program is reestablished the nearer we will be towards our objectives.

Livestock breeding and improvement plans have to be permanent to be able to bring results. Recurrent shifting of methods and objectives according to the whims of individuals will prevent lasting accomplishments in animal improvement.

Among the unfortunate consequences of the last war was the wiping out of the College livestock population. Soon after the war, however, rehabilitation of the College livestock was started so that to date the number of livestock has become sufficiently large to warrant definite plans for animal breeding and improvement. It is the purpose of this paper to present such a program.

The first step in any animal breeding program is to decide what kind or type of animal and what level of production would be ideal for the breeder's individual and local circumstances. Until a breeder knows what kind of animal he wants, he can neither select the best nor discard the worst. In addition, a breeder needs to consider the physical and biological resources and, of prime importance, the need for the animal.

A brief review of the past 34 years of work on animal breeding and improvement in the UP College of Agriculture is given here as a guide for future plans. As early as 1920 the formation of the Philamin, a new breed of draft-beef range cattle suited to Philippine conditions, was started (Gonzalez, 1932). Unfortunately the war ended the work before many of the new breed could be distributed for multiplication.

[1]General Contribution No. 870.

Manresa (1939) divided the breeding and animal improvement work of the College into two periods: (1) period of experimentation when the adaptability of the well-established breeds of improved livestock was studied and (2) period when definite steps were taken to form new breeds suited to our climate and adapted to our methods of farming. Together with this improvement work, tests were conducted on the established tropical breeds of livestock from India and Pakistan, like the Nellore and Sahiwal cattle, the Murrah carabao, and the Red Sindhi dairy breed of cattle, which showed good indication of adaptability to Philippine conditions (Villegas, 1935). Since the war a new stock of Red Sindhis has been introduced in the College.

Under the PHILCUSA-FOA program, the College, with the cooperation of various agencies of the Philippine Government engaged in animal production, has acquired some well-established livestock breeds from the United States and Australia. Among these breeds of temperate and semitropical origin are the Brown Swiss and Holstein-Friesian cattle from Australia, the Berkshire swine from Japan, and the French-Alpine, Toggenburg, and Anglo-Nubian goats.

CATTLE

The inability of cattle from temperate countries to adapt themselves to Philippine conditions was amply demonstrated throughout the long series of breed importations from the early days of American occupation to the last war. Various breeds such as the Holsteins, Guernseys, Jerseys, Ayrshires, and Herefords were imported with the hope that they could be propagated in this country. Prewar results proved very discouraging.

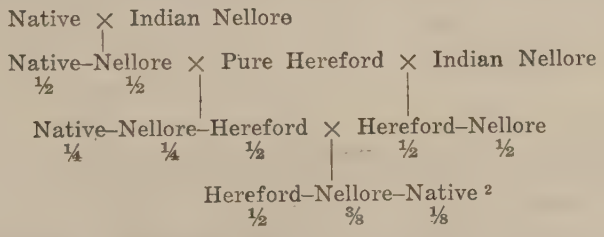
To replenish its depleted stock after World War II, the Philippine Government once again started to import dairy cattle from the United States, Australia, and India. Hermosura (1953) reported that at the Alabang Stock Farm the cow mortality was 27 per cent a year for the Holsteins imported in 1947 and the calf mortality ranged from 50 per cent for the Carnation Holsteins to 66 per cent for the other group; the cow mortality for the American Jerseys was 13 per cent a year and the calf mortality was 82 per cent; the cow mortality for the Australian Jerseys was 15 per cent a year and the calf mortality was 75 per cent; and the cow mortality for the Sahiwal breed of Indian cattle was 4 per cent and the calf mortality was 13 per cent.

Early breeding experiments at the College showed that the Indian Nellores raise 77 per cent of their young to sexual maturity; the Philippine cattle, 72 per cent; the Herefords, 42 per cent; and the Holsteins, 50 per cent. Crosses of Hereford $\times$ Philippine cattle, and Hereford $\times$ Indian Nellore have done well. Those possessing $\frac{1}{2}$ Hereford blood and $\frac{1}{2}$ of either Philippine cattle or Nellore blood have a percentage of survival of 84 per cent, those possessing $\frac{3}{4}$ Hereford have 80 per cent, and those with $\frac{7}{8}$ Hereford have only 50 per cent.

Other crosses between Philippine cattle and the newly introduced Brown Swiss, Australian Holstein, Sahiwal, and Red Sindhi breeds have been made in the College with the cooperation of the PHILCUSA-FOA. A lot of experimentation will have to be made before an estimate of their worth can be given.

Foundation stock for a breed of draft-beef range cattle. A breed of draft-beef range cattle that will thrive well under Philippine conditions and methods of farming is of prime importance to the average Filipino farmer. Largely because the well-established breeds of cattle from temperate countries are unsuitable for propagation and because importation of animals is at best irregular, difficult, and expensive, in 1920 the College, then under the deanship of the late President B. M. Gonzalez, embarked on a well-planned project of forming a breed of range cattle suited to our climate. The aim was to blend into one breed the hardiness, good grazing qualities, and resistance to disease of the Nellores; the docility, efficiency as work animals, and prolificacy of the Philippine cattle; and the rapid rate of maturity and excellent beef conformation of the Herefords (Manresa, 1939).

The foundation stock for this breed was selected from a number of crossbred animals. The data obtained in 14 years of crossbreeding experiments (Ver, 1950) showed that the animals possessing ½ Hereford blood, ¼ Nellore, and ¼ native were superior to all other combinations in size, rate of maturity, and percentage of survival. Accordingly, all cows possessing this blood composition were gathered together and the best five were placed in a different herd headed by the best bull from matings between pure Hereford males and Indian Nellore females. This herd made up the foundation stock for the Philamin breed of range cattle. A schematic diagram of the process involved in the formation of this breed follows:



In its work in forming the Santa Gertrudis breed of cattle, the King's Ranch at Texas found that Herefords and the Indian cattle do not "nick" well. In forming a new foundation stock for a new breed of draft-beef range cattle suited to Philippine farming and climatic

[2] Beginning with this generation individuals of this blood composition were mated *inter se*, and thereafter the blood composition of the resulting progeny was disregarded. Selection and culling were practiced rigidly in order to fix the type for the breed.

conditions, therefore, Shorthorn blood, in lieu of Hereford, might be included with the Indian Nellore and Philippine cattle, using essentially the same breeding plans used for the Philamin.

Quite recently the Santa Gertrudis breed of cattle from Texas was introduced at the Yulo farm in Canlubang. The FOA similarly has introduced in the Philippines the Brahman breed of cattle from Texas. While the beef production of these two breeds is not as good as that of the standard temperate breeds, it is definitely superior to that of the Indian and native breeds of beef cattle present in the Philippines. Casual observation indicates that the Santa Gertrudis and Brahman breeds have excellent prospects of being adapted to Philippine conditions and system of farming. Should this be so, our plan of breed formation should allow enough flexibility.

The Santa Gertrudis breed of cattle carries a good percentage of Brahman and Shorthorn blood so that crossing it with the native to form the stock of the Philamin breed of beef-draft cattle should be considered. The use of the Santa Gertrudis will require crosses of only these two breeds to obtain the desired characters of the Hereford, Nellore, and native. The proportion of native blood should be limited to about ⅛ of the Santa Gertrudis blood. This amount gave the best results in the formation of the Philamin breed, that is, in blending into the new breed, the docility, efficiency as work animals, and prolificacy of the Philippine cattle. The small size of the native cattle shows in crosses with more than ¼ native blood.

Rhoad (1953), in his article about the Santa Gertrudis cattle, stated:

> Experiences gained in the development of the Santa Gertrudis breed has, in the field of applied genetics, emphasized the differences in combining ability between breeds and the fact that individual merit of a crossbred is more important than the "per cent" of blood or fraction it carries of one or the other parent stock. In the early stage of breed development the search for the superior individual, both in type and breeding ability, is the important objective. After the superior individual of the new type is found, the development of the new type into a new breed requires the execution of a well-designed plan. This plan must provide for the continuity of objective.

Purification and improvement of the Indian Nellore, Red Sindhi, and Philippine cattle. Animals of tropical origin like the Indian Nellore and the Red Sindhi have done relatively well in the Philippines. Undoubtedly they can be improved through proper breeding and selection and management. The College herd of Philippine cattle, although small in number, forms a good starting point for the development of improved native oxen.

For a dairy breed of cattle the Red Sindhi has done relatively well at the College. In the Philippines at present the Red Sindhi is best known among a number of newly created tropical breeds (Villegas, 1953a). The average milk yield of the first three cows in the College from 1933 to 1938, inclusive, was well above 5 liters a day during a lactation period of not less than 300 days.

The new foundation stock of the College Philippine oxen is largely from Batangas since that province has the best stock of native cattle. These cattle are of Mexican and Chinese origin and were introduced into the Philippines during the early years of the Spanish regime (Villegas, 1935b). Natural selection gave the animals their present small size and stature. Strict selection and culling coupled with good management will undoubtedly be necessary to improve our stock of native oxen.

Program for cattle improvement. Our present problem is to make definite policies on long-range cattle improvement so that even with personnel changes the work of the College will not be impaired. The absence of a superior established breed of beef-draft range cattle and dairy cattle that can thrive under Philippine conditions and system of farming makes the establishment of a breed formation program practically indispensable.

Crossbreeding experiments should be continued. The experiments should develop knowledge that will provide a sound basis for advising livestockmen as to what results to expect if they should decide to use crossbreeding as a means of producing better replacements for their animals.

A number of new breeds from tropical and semitropical countries have lately been introduced into the Philippines. Among these are the Santa Gertrudis, Brahman, Tharparkar, Bhagnari, and Sahiwal breeds of cattle. The Brown Swiss, Holstein, and Jersey breeds from temperate and semitemperate countries have also been introduced. The first two breeds are presently undergoing crossbreeding tests in the Department of Animal Husbandry. Only after some time will we know their adaptability and suitability to Filipino needs and conditions.

Observations on the recently introduced Santa Gertrudis and Brahman breeds of cattle, although limited, indicate good possibilities of their being able to thrive in the Philippines. These breeds of cattle do not equal the temperate beef cattle in beef quality, but they are definitely superior to the native and Indian cattle in the Philippines. Their being less beefy is perhaps an advantage since it fits them better for draft purposes. These animals have been bred for resistance to diseases.

The introduction of a pure breed of Santa Gertrudis into the College herd will be well worth the price. The Santa Gertrudis cattle, as previously pointed out, have basically the temperate and Indian bloods which we require in the blend for our Philamin breed. Experiments on their adaptability to our climate and methods of farming should be conducted along pure line breeding. Crossbreeding them with the native cattle should also be studied since that would be the fastest means to improve the native stock. Similar studies should be made with Brahman cattle. Since its introduction to the Philippines about a year ago, the Brahman has done relatively well under range conditions at the Bongabong Stock Farm

of the Bureau of Animal Industry. These experiments should continue until definite conclusions can be reached concerning the value of the two breeds in crossbreeding work as well as in the formation of the Philamin breed.

The livestock improvement program calls for the use of the best breeding methods that will require the least possible time. The use of the native cattle in the improvement program has these advantages: the native cattle are widely distributed in the Philippines; they show fairly good conformation; and they thrive best in the Philippines.

At any rate, the work on breed formation, crossbreeding, and breed adaptation and improvement requires a relatively long time. To forego one phase of the work would be detrimental to the livestock industry of the country. It would be to our advantage to take definite steps simultaneously along all the lines of our long-range policies. With the current cooperation the College is getting from the other agencies of the government, such a program has a good chance of success at a relatively faster rate.

PHILIPPINE CARABAOS AND INDIAN BUFFALOES

It is possible for Philippine carabaos to have increased milk production, the Filipinos having taken care of them for many years. They have been used for farm work extensively and as sources of milk.

Prewar records of the Department of Animal Husbandry on 22 complete lactations show the average yield of the Philippine carabao cow to be 2.1 liters a day during her period of lactation; of the Indian buffaloes, 2.8 liters a day; and of the first-generation crosses between the two breeds, 2.9 liters a day. The highest daily production of the native carabao was 5.3 liters over a period of 365 lactation days; of the Indian buffaloes, 7.1 liters over a period of 242 days; and of the first-generation crosses between native carabaos and Indian buffaloes, 7.9 liters over a lactation period of 298 days (Sarao, 1934, cited by Manresa, 1939). The foregoing data indicate how much improvement can be done on carabaos.

Both breeds of carabao thrive well in the Philippines and respond most favorably to the local methods of feeding and management. A program for their improvement would therefore consist of effective independent improvement of each class of carabao. Crosses can be made for the purpose of producing immediate crossbreds. Intensive selection and culling with proper attention to milk production and other desired qualities can be made on them with less difficulty than on other farm animals.

HORSES

Repeated importations of foreign horses into the Philippines have invariably failed. Foreign breeds as pure breeds cannot survive for a long time in the Philippines (Villegas, 1953). The Ara-

bian, Thoroughbred, Morgan, Standardbred, and Welsh breeds have all failed to thrive normally although the Arabians have done better (Gonzalez, 1926).

The early breeding experiments of the College showed that the grade Arabians are better than the grade Thoroughbreds in hardiness although the latter produce larger animals which are good feeders. In breeding a general utility horse, the Philippine pony is used as basic stock and is infused with some of the smaller breeds of imported horses, notably, the Arabian or the Thoroughbred. The aim is to produce horses which are of fair size, good temperament, well-balanced action, and medium speed at the walk and the trot; which can perform many odd jobs on the farm; and which can be used as saddle horses.

The Philippine pony has been raised under the most economical conditions. Its hardiness and endurance make it the best breed to raise in the Philippines. Lack of care and attention to proper breeding and management has given the horse its present small stature and other defects. It can be improved through proper selection and culling, breeding, and management.

SWINE

The College herd of Berkjala swine, a product of some thirty years of breeding, was completely wiped out during the last war. With the help of the Bureau of Prisons the College stock has been replenished.

Much intensive selection and culling have to be done to bring the College stock to a standard. The index of selection used previously was the following: litter size, minimum of six pigs to the litter in the first farrowing and eight in the third and subsequent farrowings; motherly characteristic, being able to raise not less than 75 per cent of the young in each litter; and milking quality, a minimum total weight of the litter at weaning time of not less than 50 kilograms for the first litter, 60 kilograms for the second, and 80 kilograms for the third and subsequent litters. All animals with low selection indices should be removed from the breeding herd. If the breed improvement is to be kept up, these selection indices should be raised continually through succeeding generations. This must be begun as soon as the herd has attained the level where the majority of the animals in it can satisfy the given requirements with ease.

Some of the important points that have been aimed at in the establishment of the breed are (1) the ability of the sows to produce three litters of pigs in two years, with at least eight pigs to a litter, and wean 80 per cent of their young, (2) the attainment of the pigs of 80 kilograms weight at the age of one year and 200 kilograms at maturity in two to two and a half years, and (3) the production of a ham-bacon type of hog that will breed true to type (Mondoñedo, 1953).

In conjunction with the present PHILCUSA-FOA program, the College has acquired some Berkshires mainly for use in the present extension crossbreeding program. Keeping the animals at their pure breed stage will be the principal feature of the breeding plan since they will be used mainly for crossbreeding.

SHEEP AND GOATS

Especially among the poorer classes of people, milk consumption is exceedingly low. This is equally true of meat consumption although to a lesser degree. As a source of milk and meat, the goat offers some possibilities. With better methods of breeding, feeding, and management, the College has raised goats that give more than two liters of milk a day, or 390 liters during a lactation period of 202 days (Villegas, 1932).

Studies in the Department of Animal Husbandry have disclosed a number of reasons why goat and sheep raising has not flourished in the Philippines. Foremost is the heavy mortality among the young, primarily because of heavy infestation of intestinal parasites. Goat raising in the department from 1913 to 1922 has shown that even the well-adapted native goats will not thrive when little or no attention is given them.

Of the foreign breeds of goat, the Anglo-Nubian, Maltese, Spanish, Saanen, Alpine, Toggenburg, Angora, and Indian breeds have been introduced into the Philippines. With the exception of the Indian breed, all of them have failed to survive in the tropical environment (Gonzalez, 1926). Among those of Western origin, the Anglo-Nubian goat has done better than the others. The Indian goat has adapted itself to Philippine conditions and gives more milk than the native goat.

A breeding plan which will possibly include both the Indian and Anglo-Nubian breeds with the native stock may be adapted for the development of a dairy breed of goat that will do well in the Philippines. The pure lines of the Indian and native goats may be improved through intensive selection and culling, together with improved feeding and management.

Although sheep may never become as important as the other livestock in the Philippines, it may have possibilities as a source of mutton. The Indian sheep excels the native kind in size and in leg of mutton. Both are well adapted to Philippine conditions. Success in raising sheep is attained only after a proper system of management has been put in practice. Past and present studies have shown that when properly cared for, sheep thrive well in the Philippines.

The improvement of sheep will be along the pure lines of both Indian and native breeds, together with crossing experiments with other breeds. Much attention will have to be given to a proper system of management and other breeding improvements.

POULTRY

Repeated failures to adapt bodily the standard Western breeds of poultry to the Philippines led to the development and improvement of a new strain of Cantonese chicken, the Los Baños Cantonese, through intensive inbreeding accompanied by proper feeding and rigid selection for vigor, type, performance in egg production, and size. The whole breed unfortunately went out of existence during the last war. Since 1946, however, Dr. F. M. Fronda and his associates have managed quite successfully to select some strains of the Single Comb White Leghorn breed that perform fairly well locally. This breed has been undergoing constant improvement through methods used previously.

Also lost on account of the war was the work on the improvement of the Philippine native chicken. The work started in 1922 gave such encouraging results that another attempt to establish an improved native breed of chicken has been instituted. The process should essentially be that previously planned, that is, the use of intensive inbreeding accompanied by strict selection for vigor, type, size, and performance in egg production.

The duck also offers possibilities for improvement. The Mallard duck has been successfully used for egg production and the Muscovy duck for meat among the duck raisers in the Philippines. Improvement on them as pure breeds can be done through rigid selection and proper management.

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A REVIEW: MINERAL NUTRITION OF FRUIT CROPS[1]

For the first time in years, the cultural and nutritional requirements of fruit crops grown in the United States have been put together in a book. In a way this book is an orchardist's *vade mecum*.

Since fruit trees need several years to reach bearing age and have long productive lives, a study of their nutrition requires patience and good planning. Thus, the effect of a fertilizer or a cultural treatment given at the seedling stage is expressed in fruit quantity and quality only after several years' waiting. Furthermore, a treatment may be manifested throught several cropping seasons, not so much because of its residual effect in the soil, but because its invigorating effect may enable the tree to sustain successive heavy crops. Another point which should be considered is the extensive root system of fruit trees in which the feeding zone progressively moves away from the base. As a result, the effectiveness of a given fertilizer placement may vary from year to year.

Because of the difficulties attendant to the running of experiments under incompletely controlled conditions such as are obtainable in an orchard, most of our information on fruit nutrition is fragmentary and at times conflicting. And rather inherent with this difficulty is the tendency of results to be empirical. The presentation, therefore, of an integrated account of the nutrition of a particular fruit is almost a feat.

In this book, the literature on the nutrition of each fruit crop is reviewed by a person who has had many years' study of the crop. His choice of material and treatment of the subject, therefore, count with some authority.

In general the discussion of each fruit crop starts with a treatment of the cultural requirements; then of the essential elements nitrogen, potassium, magnesium, calcium, iron, manganese, zinc, copper, phosphorus, and boron. The aspects of each element treated are the amounts and forms naturally present in the soil, effect of soil management on availability, absorption and use of the element, symptoms of deficiency and/or excess, and control of deficiency.

One regret that Philippine agriculturists have about the book is that except for a very few, the crops discussed are not grown in the Philippines. The exceptions are citrus, avocado, and mango. However, the book contains a great many general principles in the culture of American fruit crops which, with slight modifications, may also be useful in the culture of Philippine crops. Examples of these are the application of fertilizers through leaves discussed at length

[1] General Contribution No. 871. Norman Franklin Childers (ed.), "Mineral Nutrition of Fruit Crops," Horticultural Publications, Rutgers University, New Brunswick, N.J., 1954, 907 pp.

by D. Boynton in apple nutrition; leaf analysis as an index of the fertilizer requirements of crops discussed with respect to citrus by W. Reuther and P. Smith; isotopic tracers in fruit nutrition by S. I. Wittwer and H. B. Tukey; chelated metals for growing plants by I. Stewart and C. D. Leonard; and experimental design and interpretation of results in orchard tree experiments by G. F. Potter and B. G. Sitton.

These desirable aspects commend the book to all progressive orchardists in any country and to libraries of agricultural institutions.

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COLLEGE AND ALUMNI NOTES

Bordeaux mixture, known to be an efficient fungicide for the control of diseases of cacao, citrus, fruit crops, and vegetables since the days of Dean E. B. Copeland through the work of students under the direction of Professor C. F. Baker, was shown by Visiting Professor Allan Goodrich Newhall and Research Assistant Professor Faustino T. Orillo to be one of two copper fungicides suitable for the control of coffee rust. In 1918, Emilio M. Africa published "The minimum bordeaux application for the control of Hemileia" in *The Philippine Agriculturist and Forester.* In his "Philippine economic plant diseases" published in 1918 in the *Philippine Journal of Science,* Dr. Otto A. Reinking described the preparation of Bordeaux mixture and reported the diseases that this fungicide can control.

On the basis of plans to make the UP College of Agriculture and Central Experiment Station the research center of the Far East, a document renewing the technical assistance contract between the agricultural colleges of the University of the Philippines and Cornell University was signed by Dean L. B. Uichanco in Los Baños and by Dean W. I. Myers in New York. This paper of renewal calls for an extension of the relationship of the two institutions for two and a half more years beginning July of this year.

The original provisions are for Cornell to provide assistance in the rehabilitation and expansion of the College and advice and assistance in teaching, research, and other functions of an agricultural college. To carry out such aid, the contract provides for the sending of ten American technical men to the College. Under the same contract, the UP is to provide personnel and material as can be afforded mostly through the PHILCUSA-FOA effort.

A Holstein-Friesian bull was donated by former Speaker Jose Yulo to the College dairy farm. The bull, chosen from the superior herd kept by the Canlubang sugar estate dairy farm, is expected to render excellent service.

Drs. A. G. Newhall and N. C. Brady, in a trip to Mindanao late in June, made arrangements with the Matutum Agricultural Development Co. in Cotabato for cooperative experimental work on coffee. For the control of rust Dr. Newhall made the initial application of eight different fungicides and Dr. Brady initiated experiments on fertilizers. With Drs. F. T. Orillo and N. L. Galvez, a trip of similar nature was made to Baguio from July 11 to 13. Keeping up with the coffee issue, the plant pathology department is testing approximately 600 coffee plants, which were collected in Africa, for resistance to disease especially to coffee rust.

Dr. J. R. Velasco went on a botanical trip to Palawan in May. Juan V. Pancho, agricultural botany staff member, was officially

detailed for a month to the marine biological station in Puerto Galera in Mindoro. He took courses on morphology and taxonomy of algae.

Dr. F. M. Sacay, representing the DANR in the Rehabilitation Finance Corporation Committee on Abaca Loans, made a three-week study trip to Mindanao to study the farmers' ability to earn and pay amortization to the RFC as a result of damages caused by mosaic, low price of abaca, and high cost of production.

"Farm mechanization is here to stay," A. B. Catambay, professor and head of the Department of Agricultural Engineering, told guests who attended Farm Mechanization Day which was held on the campus last July. Whether one uses machines in the farm or not, he continued, one must know how to take advantage of them for varied purposes when they are available. After enunciating the keynote of the day, Prof. Catambay suggested among other things that the farm owner with only four hectares of land or less should use the traditional carabao-and-plow culture. The guests were welcomed by Dean Santos.

Commercial firms that were invited to participate demonstrated the use of farm machines in plowing upland and lowland fields, contour plowing, cultivation of row crops, baling, and other processes. Among the visitors were Col. Osmundo Mondoñedo of ACCFA, Vicente Araneta, landowner and former administrator of ACCFA, Director C. V. Crucillo of the BPI, representatives from other DANR bureaus and commercial firms.

The field day was the second of several which were planned out by the College Committee on Field Days in cooperation with agencies of DANR as a phase of extension services.

Jose O. Juliano, '52, instructor in chemistry, received his Master of Science degree from the Louisiana State University at the commencement exercises held last May. He specialized in sugar technology. He was elected to the honorary chemical society of Phi Lambda Upsilon and to the Sigma Xi. He is presently pursuing postgraduate studies in the University of California in Berkeley.

Pedro R. Sandoval, '46, and Severino R. Santos, Jr., '52, have been appointed staff members of the Department of Agricultural Education. They were formerly with the Fertilizer Administration.

Flying back late last month from Massachusetts was Edelwina Cu of the languages department. She earned a Master's degree in English at Radcliffe College on a year of Fulbright Smith-Mundt benefits. She resumes her teaching duties immediately.

The regular scientific meeting of the Los Baños Biological Club was held on July 30 at four in the afternoon at the chemistry lecture hall. A comparative study of the College Cooperative Co., Inc. business for a period of years was presented by William L. Fernandez, former cooperative store manager.

A memorial and social center to be called the Gonzalez Memorial Hall, the pet project of the B. M. Gonzalez Memorial Fund Campaign Committee, has been designed by Antonio V. Bañas, Jose Herrera, and Jose M. Vibar, Jr. at the expense of Eligio J. Tavanlar, '26. However, it seems that the necessary building sum of ₱100,000 remains to be raised. In the March report of Committee Treasurer Sacay, "there are many pledges but these have not been transformed into cash."

Burton T. Oñate, '47, is cooperating as a staff member of the newly established Statistical Training Center of the University which offers a three-semester course leading to the degree of Master of Arts in Statistics. The Center is a permanent venture of the Philippines and the United Nations. Other staff members are Max Lacroix of the UN, Meredith G. Givens who is principal adviser to the Center, Satya B. Sen of the Indian Statistical Institute, Dr. Victor V. Valenzuela of the Institute of Hygiene, and Cristina Parel of the University mathematics department.

The 226th regular scientific meeting of the Los Baños Biological Club was held in the afternoon of August 27 at the chemistry lecture hall. Dr. Valente Villegas of the Department of Animal Husbandry presented a paper on the capacity and measurements of the digestive tract of sheep.

A survey of the relentless cadang-cadang of coconut in Guinobatan, Albay, was undertaken by a force of College specialists from the 4th to 7th of September. Headed by Dean Uichanco, the group was composed of Dr. Newhall of Plant Pathology, Dr. Brady of Soils, Dr. Velasco of Agricultural Botany, Dr. Banzon of Agricultural Chemistry, and Prof. Mondoñedo of Agronomy. A summary-suggestions conference was held on the 13th.

The service record of Dr. Francisco M. Sacay, recently appointed assistant administrator of the Agricultural Credit and Cooperative Financing Administration (ACCFA), proves that the well-serving youth makes the successful man. Only half a century old, Dr. Sacay has exactly 29 years, 5 months, and 6 days of service with the College of Agriculture behind him, part of which has been spent in handling extension work and publications projects of the College.

The 227th meeting of the Los Baños Biological Club was held on September 24 at 4:15 in the afternoon at the chemistry lecture hall. Dr. Jose R. Velasco of the agricultural botany department presented a paper on a germination inhibitor in the fruit of *Carica papaya* Linn.